# On the Control of Science: Four Views

# *science and public affairs*

## BULLETIN OF THE ATOMIC SCIENTISTS


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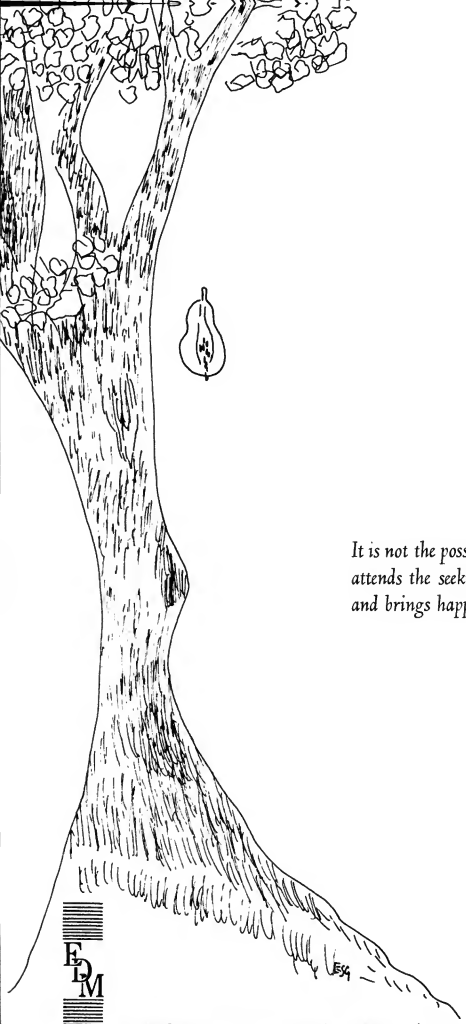

*It is not the possession of truth, but the success which attends the seeking after it, that enriches the seeker and brings happiness to him.* MAX PLANCK

# *Science and Public Affairs*


## BULLETIN OF THE ATOMIC SCIENTISTS

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## COMMUNICATIONS



## ARTICLES



## CREDITS

Cover: Nuclear Standard Time; the *BULLETIN* continues to watch the clock. Design, Jack Jordan. Artists in this issue: Hoppes, page 2; Dempster, pp. 3, 10; Brown, pp. 5, 24, 35; Harris, pp. 29, 37; Rencin, pp. 47, 51, 53, 55.

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# *Communications*

## Relevance of Space

I think Arthur Kantrowitz is doing the serious space effort considerably more damage than benefit with his article about "The Relevance of Space" (**Bulletin**, April 1971).

First, Dr. Kantrowitz is making it very easy for himself, in dismissing the critics of the results of technology as "fashionable," "frequently superficial" and as "naive pessimism," without any attempt to distinguish between different types and topics of the critics. He also claims that these types of critical views are producing an impact as self-fulfilling prophecies with "deadening consequences."

Does he mean, for example, that concern about the arms race is naive pessimism with deadening consequences? Or that suggestions that the money put into some of the space projects could be used in other ways are superficial? It is unfair to dismiss one of the most urgent problems of today, that of proper use of limited resources, in this way.

Dr. Kantrowitz' purpose in his article is obviously to defend the usefulness of a continued, large space program. He puts forward a suggestion of mass emigration into space as a mean of solving the overpopulation problem of the Earth. He then discusses where all these space people could be employed, to be economically viable. He finds that "generation, processing and transmission of knowledge" is an activity where "space groups would not find themselves at any economic disadvantage compared to their earthbound competitors."

There are several points in the article I would like to comment on. Is it overall possible to fight an increasing world population with space emigration? Or, as Dr. Kantrowitz puts it, "Let me ask if there is a solid reason why this hope cannot be seriously put forth?" I think there are some solid reasons against this hope, but they are of course not technical but mainly economical in nature.

Allow me to make some very qualitative calculations, to show what I mean. The yearly increase in world population is about 100 million, which means a daily increase of about 250,000. Imagine large space shuttles each carrying 1,000 passengers. This means one lift-off every fifth minute to cope with the population growth. If we use Dr. Kantrowitz' figures, then the energy cost of $10 per pound in orbit could be attained, and each person could be allowed to bring 10,000 pounds to keep alive. From that we get a cost of $100,000 per person in orbit. This, in turn, means a total energy cost of $10,000 billion ($10^{13}$) per year, which is 10 times the present gross national product of the United States. On top of that we now have to add the cost of building and maintenance of large spaceships and stations, which probably requires much more investments than the energy to put it all into orbit.

This is only from the economical point of view. Who is now going to give this all to the people of the poor countries, who account for most of the population growth, and do they want to have it? What people should be selected for a life in space, and who should be left on a possibly more and more unpleasant Earth?

If you want to defend space research and technology there are other applications, more serious, that should be discussed, for example, scientific exploration, improved weather forecasting, mapping of natural resources and the like. Of course, these applications are not necessarily of pure benefit to mankind, their value depends on who is using them and how they are used. Here is the field where a discussion of "The Relevance of Space" should take place.

It is also necessary that a discussion on the overpopulation problem should be held in more socioeconomic terms, to really make one understand the nature of the problems. Technical solutions, like mass transportations, could at most take away some of the symptoms of a wrong system.

The proposition to let the space stations become economically viable

by making them deal with "generation, processing and transmission of knowledge," or plainly be schools, is to me an unnecessary and dangerous one. Do we really need to go up in space to be able to think? The problems to be solved on Earth—in order to make it habitable to all mankind—are definitely of the type that require the presence and active participation of the problem-solvers. A kind of elite, at least socially, completely isolated up in the sky can never solve those problems in an acceptable way. As an example, let us just look at ourselves, isolated from the poor peoples in an environment completely different from theirs. We are obviously not able to efficiently attack and solve the main problems of the poor countries, problems like uneven income distribution, land reforms, democratic governments, freedom from sickness, etc. And we already have, for example, in the universities, lots of quiet thinking places with good communications to the surrounding world, as good as between space and earth.

I think that Dr. Kantrowitz' proposition is sheer romanticism, and I hope that this odd suggestion of solving the population problem will soon be forgotten, for the benefit of the more realistic discussion. I also believe here is a place where the Pugwash movement could find an important role to play, in pointing at the real problems and initiating relevant discussions.

Lars Kristoferson

*Division of Plasma Physics*
*The Royal Institute of Technology*
*Stockholm, Sweden*

* * *

Arthur Kantrowitz' classification of misgivings about uncontrolled and haphazard growth of technology as "naive pessimism" is naive, and since he chooses to classify people of different ideas it might be called "naive irrelevance."

Assuming that emigration to space is possible opens the way to pour further untold amounts of money into space research. But it bypasses the questions if this would represent an advance for man, and if this is a problem deserving priority under today's conditions?

Man has not begun to solve problems of a social or ethical nature; problems which are aggravated by the "thing mindedness" fostered by technology and its handmaiden, Madison Avenue. The people of the earth are blessed with all kinds of technical gadgets and innovations, and this stream drives man away from real advancement. Needless to say, we cannot do without technology: we could not hope to feed and house the people living today, let alone those expected, even under best circumstances, by the end of the century.

But the technology we need is one of housing, transportation (mass transportation, not more individual cars), health care, etc. We should devote all our technological skills to these fields rather than to exploration of space, because we might at some time be able to migrate into space.

And we should spend an infinitely larger effort on understanding and reducing human friction, injustices and inequalities.

In light of these needs to speak of space exploration at all, certainly in the sense of practical application, is irrelevant and naive, if not outright indecent.

Victor Paschkis

*Pottstown, Pa.*

## Kantrowitz Replies

Kristoferson's critique of my article makes points criticizing elements which I never claimed. I never said, for example, that the concern about the arms race is naive pessimism. Regarding the economic calculation he makes, he chooses the highest figure that I gave, 500 times the energy cost, and then adds costs on top of that. It seems to me very likely that the high figure I gave for the energy cost of launching into space is a target we will learn to surpass. In addition, he asks if our present economy would support the launching of all of the current population increases into space. I agree that it will not.

It seems to me that among the many things we must do about the population explosion, it is wise to open up options in space. To implement these options we must hope that in the future the world economy will continue to expand as it has in the past.

I was pleased to note that in emphasizing the question "what people should be selected for a life in space, . . ." Kristoferson seems to accept my hope that it will eventually be more attractive than life on earth.

Arthur Kantrowitz

*Everett, Mass.*

WALTER C. CLEMENS, JR.

*Andrei Sakharov, who is regarded more than any other scientist as the father of the Russian hydrogen bomb, "may also be recorded in history as one of the most valiant and perhaps successful fighters for political freedom and human rights in the Soviet Union." Here is "a man for our times." Professor Clemens, a political scientist at Boston University, is an associate of the Russian Research Center, Harvard University.*

# SAKHAROV: A Man For Our Times

Shulubin, a patient in Solzhenitsyn's "Cancer Ward" quotes a few lines of Pushkin for Oleg, another inmate:

> In our vile times
> . . . Man was, whatever his element,
> Either tyrant or traitor or prisoner!

Oleg had spent the best years of his life in prison camps or in exile, while Shulubin had been "free" on the outside. Though not a prisoner, Shulubin felt himself a traitor. For he had voted with the majority to denounce and destroy other persons; as a teacher he had mouthed whatever doctrines were approved; demoted to a librarian, he burned whatever books were condemned. More than Oleg, he had lived in fear.

Andrei Sakharov has been neither tyrant nor, as yet, a prisoner. He has been true to his own ideals, and hence no traitor—at least in the sense of Pushkin and Shulubin.

More than any other scientist, "father of the Soviet hydrogen bomb," Sakharov may also be recorded in history as one of the most valiant and perhaps successful fighters for political freedom and human rights in the Soviet Union. In the late 1940s and early 1950s his contributions were decisive to his country's mastering of fusion weaponry. By the late 1950s, however, he emerged as a social critic and innovator, even while continuing his work in physics, which seems to have broadened its focus from intensive study of minute fragments of matter and energy to a concentration on the totality of the universe. In 1959 he opposed the glacial leveling thrust of Khrushchev's educational reforms and championed special schools for gifted children and a revitalization of mathematics in the entire educational system. In the early 1960s Sakharov entered the struggle against Party dictation and Lysenkoism in genetics. When the Party considered rehabilitating Stalin in the mid-1960s, Sakharov joined others in a letter of protest which seems to have stayed the hand of the neo-Stalinists.

These efforts were spectacular in Soviet conditions, both for their courage and also for their degree of success. But they were eclipsed by a series of programmatic statements authored or co-authored by Sakharov in 1968-70. Besides his participation in numerous protests directed against the arrest or incarceration of individual dissidents, Sakharov has drafted or co-authored three major statements that stand in logical sequence to each other. His longest and most general essay has been the manuscript "Thoughts on Progress, Peaceful Coexistence and Intellectual Freedom," which was privately circulated in the USSR in 1968. (It was published by the "New York Times" on July 22, 1968, and subsequently as a book by W. W. Norton, with an introduction and notes by Harrison Salisbury.)

Much of the Soviet's 1968 plan dealt with international cooperation, and hence was dependent for its implementation on actors outside the Soviet Union. But in 1970 Sakharov helped to draft two additional documents pertaining directly to Soviet life. In March 1970 Sakharov together with Valentin F. Turchin, a scientist, and Roy A. Medvedev, a historian, wrote a letter to the Party and government of the USSR suggesting 14 points for increasing the role of freedom in the Soviet economics and politics. Applying some of these points, Sakharov and two other physicists, Andrei N. Tverdokhlebov and Valery N. Chalidze, announced in November 1970 the formation of a Committee for Human Rights to seek ways of guaranteeing personal freedom in the Soviet Union.

As a member of this Committee, Sakharov sent an open appeal to the Supreme Soviet on September 20, 1971, urging that all bars on emigration be lifted. The letter, circulated among foreign newsmen by dissident sources, also demanded an amnesty for all citizens who have been jailed for illegally attempting to leave the country, as well as an amendment to the criminal code designed to remove the stigma of "high treason" from such attempts.

Each of these documents, it should be emphasized, calls for reform within the system. This stress on the desirability and feasibility of the legal system as a vehicle for reform is not shared by many Soviet dissidents, some of whom urge civil disobedience. If the changes advocated by Sakharov and other legalist reformers were accepted, however, they would surely be revolutionary in the sense of bringing about major changes in Soviet life. Like the aborted reforms of Alexander Dubcek in Czechoslovakia, Sakharov's suggestions may be one of the most powerful ways of revitalizing the

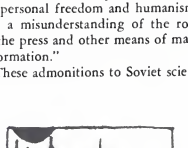
moribund communism of the Soviet sphere. Not surprisingly, however, the Communist Party of the Soviet Union has expressed a growing alarm over the efforts of Sakharov and others like him.

### *Scientists Criticized*

The importance of Sakharov's ideas and the influence of his demands for greater freedom at all levels of Soviet life were attested in October 1970 by a special report of the Party's Central Committee criticizing scientists at the country's leading physics institute, where Sakharov works, for showing insufficient hostility to Western ideas. The Central Committee's report, published in the bimonthly Party journal, "Partiinaya Zhizn'," rebuked the local Party organization at the Academy of Sciences' Lebedev Institute in Moscow for inadequate activity in the ideological sphere. The local Party cell, the report charged, "insufficiently analyzes the ideological and political work in the collective of the institute and looks after its further improvement in weak fashion." To rectify the situation, the Central Committee ordered a stepped-up campaign there to "instill among scientists an irreconcilable attitude to the ideological conceptions of anti-Communism and revisionism." Such efforts were needed, the report declared, because scientists at the institute "do not have permanent ties with the working collective; insufficiently engage in the dissemination and propaganda of scientific knowledge; work on and publish few works on the philosophical problems of natural science; and do not show necessary staunchness in the struggle against unscientific, idealistic conceptions of bourgeois scientists."

The Central Committee appeared to be raising the sights of its own campaign to keep Soviet intelligentsia within the bounds of Party orthodoxy. Earlier criticisms published in "Kommunist" in December 1968 and in "Sovetskaya Rossiya" in February 1969 were ostensibly aimed at younger scientists, although they certainly contained an implicit warning to senior scientists to toe the line as well. The 1968 "Kommunist" article, for example, expressed concern that some of the younger scientists at the Obninsk Physical Energy Institute "regard such concepts as democracy, freedom of personality and humanism as abstract concepts outside of the class context." The Party journal blamed senior scientists for neglect of the ideological indoctrination of their younger colleagues, reporting that directors of research institutes sometimes replied to criticism by saying: "I need scientists, not propagandists; a scientist should be concerned only with science." Reporting a similar state of affairs, the newspaper "Sovetskaya Rossiya" noted that young scientists often showed signs of "skepticism, apolitical attitudes, nonclass interpretations of such concepts of democracy, personal freedom and humanism, and a misunderstanding of the role of the press and other means of mass information."

These admonitions to Soviet scien-



tists were part of a larger campaign initiated by a set of stringent resolutions passed at the Communist Party plenum in April 1968, calling for more ideological awareness among the Soviet people. The Party was concerned because of the growing apathy among the Soviet people toward matters of ideology (a trend that Moscow has tried to counter in part by its handling of the dangers along the Sino-Soviet frontier); an increase in protest movements and underground literature; and the challenge in 1968 from the uncensored and dynamic movement toward socialism with a human face in Czechoslovakia. This was also the context in which Sakharov's manuscript appeared—"Thoughts on Progress, Peaceful Coexistence and Intellectual Freedom"—the very title of which resonated with the "nonclass conceptions" judged unacceptable by the Party press.

### *Impact Evaluated*

It is difficult to evaluate the impact of Sakharov's ideas, but it seems likely that they have been widely disseminated in Soviet intellectual circles and that they have been reviewed by leaders of the Party and government apparatus. Soviet participants in international scientific conferences indicate that his ideas have received a positive response from many if not most intellectuals, though many Soviet scholars find part of his suggestions to be naive, silly or counterproductive at this moment in time. Many Soviets find his appraisal of U.S. foreign policy behavior to be particularly optimistic, and his notions for reform of Soviet society to be quite utopian. Indeed, it would seem quite unlikely that the guardians of ideological orthodoxy in Moscow and—still more—in provincial Party headquarters could look with anything less than deep alarm at the challenge which Sakharov and other intellectuals present to the status quo. It is even more doubtful that Sakharov's way of thinking is familiar among the working and peasant classes of Soviet society or that, if reported to them, they would welcome the programs he advocates.

Sakharov's proposals and those of other Soviet intellectuals are important, however, no matter how circumscribed their following may be at this time. This essay will attempt, first, to describe the milieux in which these intellectual currents have developed and, second, to analyze some of the prospects for the political action programs he puts forward, for the USSR, for superpower cooperation and for international cooperation generally.

The major essays circulated by Sakharov in 1968 and 1970, together with the statements of protest signed by him and other scientists in support of the civil rights of Soviet dissenters, jolted me. This was in part because of my own experiences as a visitor to the Soviet Union on four occasions, the first being in 1958-59 when I took part in the first year-long exchange of U.S. and Soviet graduate students.

The level of intellectual activity

in the social sciences in 1958 was, from all appearances, quite dull and repressed. Women and army veterans were conspicuous in the faculties of history, literature and philosophy, while the brightest young men went into "mechanical mathematics," physics and biology (in that order). Those bright young men who could not stand city life—close to the danger of Party dictation—chose fields such as geology or geography that would take them to the unexplored regions of the Soviet Union. While I seldom discussed politics with natural scientists at that time, it was noticeable that they seemed to take the opposite side from social scientists whenever the university arranged a debate on a subject such as "the value of art in the modern world." Such debates were intended, from the Party's standpoint, to reaffirm socialist realism as against modern, abstract art. While my history colleagues usually argued that art should be understandable to the masses, students of physics maintained that their research demonstrated "reality" to be many-faceted, unable to be captured by any one-dimensional mode of expression.

### *Dogmas Challenged?*

I left Moscow in 1959 wondering whether the scientists of tomorrow might not be entertaining ways of thought profoundly at variance with those that had been upheld by Stalin and his successors. At the same time, Western sociologists were debating the significance of the new technocratic and scientific intelligentsia in the socialist countries. Some sociologists contended that freedom of thought was necessary for scientific research, and that this would produce a spirit of open-ended inquiry that would eventually challenge the dogmas of the Party line. A more pessimistic analysis held that scientists could be insulated, and that engineers were particularly likely to have a narrow vision limited to their practical specialty. Furthermore, these men would understand that their right to carry on scientific or technological investigation, as well as to acquire personal affluence, was contingent on working faithfully within the system. Both lines of argument were plausible; only time and further events would indicate which side was empirically correct.

Some evidence to support the more optimistic version of this argument began to accumulate for me as I met Soviet scientists involved in the Pugwash movement, a series of annual conferences at which scientists from the United States and the Soviet Union, as well as many other countries, discuss key problems of science and world affairs. Like many of their American colleagues, writing in such journals as the **Bulletin**, these Soviet scientists demonstrated a deep interest in social problems and a creative approach to them, having little in common with the pedestrian approach evident in the social science departments of Soviet universities. One man that made a particularly deep impression on me was Sakharov's mentor: the white-haired Igor Tamm, a Noble prize-winning physicist whom I met during an interlude in the 1962 Pugwash conference held in London, where we talked on a boat trip up the Thames. His deeply lined face and penetrating eyes seemed to suggest the concerns that he felt for humanity as a whole. But I wondered whether Tamm's attitudes did not reflect the fact that he had spent much time abroad and/or that he was now reaching the end of his career, so that his views would be much different from Soviet scientists with little knowledge of life in other countries or whose own careers would suffer dramatically if they displayed unorthodox views.

### *1968 Sakharov Manifesto*

None of these experiences prepared me for the Sakharov manuscript on progress, coexistence and intellectual freedom, which the "New York Times" published in 1968. This work gives us the fuller spectrum of the thinking that lay behind the letter that Sakharov, Turchin and Medvedev sent to leaders of the Soviet Party and the government on March 19, 1970. This 1968 manifesto, I thought, provided the most penetrating analysis of modern society and the most farsighted prescription for its ills that I had ever seen. I took a copy of the manuscript with me that summer to Czechoslovakia, and found that many intellectuals there had heard of it, but had not yet read it. Later that year I discussed the manuscript also with some Soviet economists and historians who said they were "familiar" with Sakharov's work (thus begging the question of whether they had actually read it), and judged it to be "unrealistic." Just why it was unrealistic, however, they did not say.

Realistic or not, the book registered a great impact on American scholars as well as those in other countries. At the Massachusetts Institute of Technology, for example, a symposium was held on the Sakharov manuscript, in which I. I. Rabi, Jerome B. Wiesner, Bernard Feld and other distinguished American scientists discussed the responsibility of intellectuals, the relation between science and politics and other topics developed by Sakharov. A group was formed to write a kind of American analogue to the Sakharov manuscript; one that analyzed its relevance to the United States and that developed points that Sakharov omitted or touched on only lightly. But this group never succeeded in drafting a comprehensive rejoinder, partly because of the breadth of topics Sakharov had integrated in his own memorandum and partly because of the difficulty in hammering out a statement acceptable to a group. Nevertheless, a number of individuals in the United States and Europe have published personal responses to the Sakharov manuscript.

The potential global significance of the Sakharov manifesto—apart from its relevance to Soviet society—was underscored in a letter by Charles C. Gillispie to the "New York Times" (July 28, 1968) shortly after publication of the manuscript:

> In its rationality, factuality and humanity, it is a bracing document.
>
> What a change there could be if this restrained but urgent statement became a charter for a serious movement among rational and informed people to lead opinion and policy in the direction of the recommendations.
>
> There must be a host of such persons who, deeply apprehensive

*(Continued on page 51)*

MARTIN L. PERL

# SALT and Its Illusions

*"I expect no more from SALT than from the Test-Ban Treaty because the SALT talks are being conducted by the same diplomatic methods. . . . There is the same emphasis on petty maneuvering and on minor technical questions. There is the same intrusion of other international problems. There are the same controlled leaks to the press. There is the same almost paranoid cautiousness on both sides. . . . The entire atmosphere is more suitable to a 1920 negotiation on naval limitations or Balkan boundaries."* Professor Perl is professor of physics at the Stanford Linear Accelerator Center.

The major objectives of the Strategic Arms Limitation Talks are to stop the nuclear arms race, to begin nuclear disarmament and to reduce the probability of the outbreak of nuclear war. As the talks continue, there is rising optimism in the American scientific community that the talks will achieve these objectives. Because scientists are especially aware of the terrible costs and dangers of the nuclear arms race, any development which may lead to a reduction of these costs and dangers will be viewed optimistically by them. But the crucial question is whether this optimism is justified. My position is that this optimism is very probably not justified, and that we may become the victims of false and perhaps dangerous wishful thinking.

There is little doubt but that SALT will lead to headline-producing agreements on some specific aspects of nuclear weapons. These agreements are expected to limit the size of ABM (antiballistic missile) systems, to limit the number of land-based ICBMs (intercontinental ballistic missiles) and perhaps to limit the number of submarines carrying missiles with nuclear warheads. However, achieving these agreements is by no means the same as achieving the major objectives of SALT. In fact, equating these narrow agreements with the major objectives of the talks can only be done if one adopts a number of misconceptions or illusions about the nature of the nuclear arms race. I believe it is the adoption of one or more of these illusions which permits the scientific community to be optimistic.

The first illusion is that SALT can be truly successful even though both the United States and the Soviet Union continue the installation of MIRV (multiple independently-targeted reentry vehicles) warheads on their intercontinental missiles. This illusion, "nuclear stability through, or in spite of, MIRV" has been discussed by others and I shall only summarize the arguments. The second illusion is broader and deeper. MIRV is only the latest example of a major innovation in nuclear weapons technology, an innovation which will increase the instability of the arms race. The ultimate effect of most research, development and testing in offensive and defensive nuclear weapons technology is to produce such destabilizing innovations. Thus the second illusion is that the major objectives of SALT can be attained even though the superpowers continue to carry out research, development and testing on nuclear weapons technology. The third illusion is somewhat different. It is the illusion that, even though SALT's concrete accomplishments turn out to be small, the talks are a useful first step. This is the mildest of the illusions because it is based on the smallest amount of optimism, but it may be the most dangerous.

I shall use the conventional phrase, "nuclear arms race," to describe the situation in which both superpowers continually increase the number and types of their nuclear weaponry, sometimes to get ahead of their adversary, sometimes to catch up with their adversary. I include defensive weapons because they can be just as threatening as offensive weapons. The word "race" is not a good one because there is no final goal in this race, but I have not found a better word. For example the phrase "mutual growth of nuclear weaponry" misses the fits and starts, the erratic changes of pace, which characterize the increase.

Most thinking about the nuclear arms race and most negotiations about nuclear weapons are based on the concept of mutual deterrence. Similarly the illusions about the nuclear arms race are intimately connected with the deterrence concept.

For 20 years the United States and the Soviet Union have been increasing the quantity and the effectiveness of their nuclear weapons. Yet there has been no nuclear war. It is generally believed that the reason there has been no war is that a situation of mutual deterrence has existed. The absence of nuclear war in the late 1950s and in the 1960s is attributed to the circumstance that neither the United States nor the Soviet Union could completely destroy the other side's nuclear weapons by a first strike. No matter who struck first, the other side could always retaliate with nuclear weapons in sufficient quantity to cause enormous death and destruction. Thus

both countries were able to deter the other country from starting a nuclear war. This then is the mutual deterrence concept.

The concept of mutual deterrence certainly has value both as an explanation of the historic fact that there has been no nuclear war and as a basis for strategic thinking. But it has taken on an importance far beyond that value. Both the United States and the Soviet Union now believe fervently and almost religiously in the importance of the deterrence concept and in the importance of their deterrent forces. The major concerns of both sides are how to strengthen their own deterrent, how to protect their own deterrent, how to weaken the other side's deterrent. The major question associated with any change in the number or kinds of strategic weapons is "What will it do to our deterrent and what will it do to their deterrent?"

For the United States the preservation and safety of its deterrent forces has now assumed overwhelming symbolic importance. The same appears to be true for the Soviet Union. Any threat to those deterrent forces is taken very seriously. It does not matter if the threat is small compared to the size of the deterrent force, if the threat is directed toward only one part of the deterrent forces or if the threat will occur 5 or 10 years in the future. In many ways the deterrent forces have become the symbol of the nation's virility. Even the language of deterrence is the language of virility. "Is our deterrent aging?" "Is our deterrent obsolescent?" "To lose one's deterrent is to lose everything." (I shall return several times to this concept — necessary for the understanding of much of the dynamics of the nuclear arms race and SALT.)

There are three pillars which, both for the United States and the Soviet Union, support the belief in the effectiveness of the deterrence concept. One pillar, which is now being threatened by the advent of MIRV, is the fact that a missile carrying a single warhead can only attack one target on the ground. In the past, to destroy an opponent's ground-based missile force, one had to expend at least as many missiles as

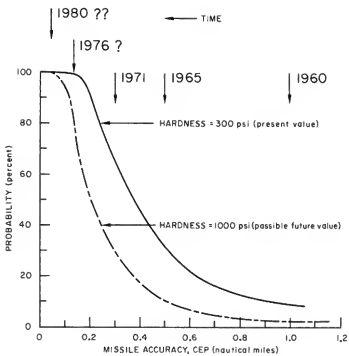



FIGURE 1

one wished to destroy. In fact, to be sure that complete destruction was achieved one would have had to expend many missiles for each opponent's missile; there was a disadvantage in making a first strike. Thus, in the 1960s, one of the pillars of the deterrence concept was the relative ineffectiveness of a first strike against land-based missiles.

A second pillar of the deterrence concept is the invulnerability of missile-carrying, nuclear-powered submarines. No nation has built a system which can find and destroy these submarines, so that a nation with such a submarine force can always retaliate after it is initially attacked.

The third pillar of the deterrence concept is the present technical inability of any nation to build an effective ABM system. A country contemplating making a first strike in a nuclear war must face the facts that (1) the attacked nation will retaliate with missiles armed with nuclear weapons and (2) the attacking nation will not be able to shoot down a substantial number of these retaliating missiles.

### *First Illusion*

I have noted that in the 1960s one of the pillars of the deterrence concept was the low effectiveness of a first strike against land-based missiles. MIRV is rapidly increasing that effectiveness and is thus destroying that pillar. This increased effectiveness comes from two technical improvements — the placing of several independently-targeted warheads on a single missile and the increased accuracy of the targeting of the warheads. The effectiveness is easily calculated by the formula presented below.

$$P = \left[\begin{array}{c}\text{probability of destroying}\\ \text{one missile site}\end{array}\right] = 1 - \left[\frac{1}{2}\right]^{\left[\frac{39\,y^{2/3}\,N}{H\,(CEP)^2}\right]}$$

In the formula y is the warhead yield in megatons, N is the number of warheads attacking the site, H is the hardness of the site in pounds per square inch and CEP is the radius of a circle, in nautical miles, within which the warhead has a 50 per cent change of landing. With the advent of MIRV, N increases and the CEP decreases. Thus the probability approaches 1. This is shown in Figure 1 for H = 300 psi, the hardness of existing sites and for a hypothetical future hardness of 1,000 psi. At the beginning of the 1960s the CEP was about one mile, now it is about one-

quarter mile for the Minuteman III, in five years it will probably be one-eighth mile, and even one-twentieth mile — a city block — is thought to be technically feasible. When P goes above 95 per cent one of the pillars of the deterrence concept begins to crumble. Figure 1 will help to indicate when this will happen.

Yet from a rational standpoint this crumbling of one of the pillars of the deterrence concept does not seem desperately serious. After all, there are still two pillars left. The advent of MIRV does not threaten the safety of missile-carrying submarines. The advent of MIRV does not change the inability of any nation to build an effective ABM system. Add to all this the fact that the United States possesses a large, nuclear-bomb-carrying, Strategic Air Force and the fact that both superpowers possess large numbers of tactical nuclear weapons. Thus the reality is that the strength of the deterrent forces on both sides is still enormous in spite of the coming of MIRV. But unfortunately it is mostly not reality that now controls strategic thinking; it is the symbolism of the deterrence concept which is of paramount importance. Only one part of our deterrent forces, the land-based ICBMs, is being threatened. But that threat is by itself of great symbolic importance. Therefore it must be answered with an amount of activity and with

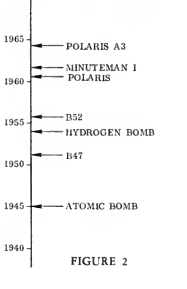


FIGURE 2

a desperation far in excess of the real extent of the threat.

The governments of the United States and the Soviet Union are both answering the MIRV threat to their land-based ICBM deterrence forces in the same way. They are each trying to make better MIRV-type missiles. They are each thinking about hardening missile sites and about building ABM systems to protect missile sites. They are both pushing R&D to find technical counter-threats to MIRV. All these activities to counter MIRV lead to instabilities in and escalations of the nuclear arms race. The escalations do not appear as increases in the number of weapons but as escalations in the effectiveness of defensive and offensive weapons. The major objectives of SALT are completely incompatible with such activities. Yet there is no expectation that SALT will lead to any agreements limiting these destabilizing activities.

### *Second Illusion*

Although the appearance of MIRV is frightening enough in itself, we must realize that MIRV is only the latest example of how technological innovations produce instabilities of and escalations in the nuclear arms race. Consider what would happen if a method was found to find and destroy, in a short time period, 90 per cent of a nation's nuclear submarine fleet. Such a discovery would destroy the second pillar of the deterrence concept — the invulnerability of the missile-carrying, nuclear submarine.

It does not really matter if the United States should find the method first; the Soviets would certainly develop it in a few years. What would we do? We could increase our missile-carrying submarine fleet from 40 to 400 vessels, thus still having 40 vessels left for a retaliatory attack, but breaking perhaps an agreement produced at SALT. Or we could start a large research program on counter-counter measures. Or we could think about a preemptive first strike before our submarines were actually threatened. We can take our choice as to which of these we would do, but whichever we choose it will be an escalation of the arms race. Finally one must realize that for this escalation to occur it is not necessary that a 90 per cent effective method of destroying nuclear submarines be found. This escalation can occur even if there is only the threat or the fear that such a method is about to be discovered!

How probable is it that a way can be developed effectively to find and destroy nuclear submarines? It is more probable than we would like it to be, for we would like that probability to be precisely zero. V. Anderson, an authority on ocean technology, has written, in the "Impact of New Technologies on the Arms Race," that new acoustic detection technology "virtually removes the technical barriers to oceanwide ASW [antisubmarine warfare] surveillance and enfolds it in the economic constraints that are dictated by the strategic importance assigned to such a capability." According to this authority, the threat or the fear is already here; indeed the only restraint would be the cost. Other authorities do not agree that the solution to the technical problems are yet apparent, but both the United States and the Soviet Union are carrying out extensive research on the technology of antisubmarine warfare. Scientists who believe that this technology cannot be substantially improved are, for scientists, in a strange position. They must believe that we now know substantially all that can ever be known about this technology or they must believe that somehow the researchers in this field will all be incompetent.

There is no need to discuss with the same detail the third pillar of the deterrence concept — the present technical inability of any nation to build an effective ABM. It is not for the lack of trying that such an inability still exists. And even an ABM system that hardly works can be built using as one of the arguments the reasoning that the experience gained will be helpful in building an ABM that works. There is no doubt that it is the intention of our Executive branch to find out how to build an effective ABM. This, like the ASW research, illustrates the continuous and intense effort made by governments to find new techniques and to develop new devices for use in the nuclear arms race.

But this is not a new problem.

on the average, every four years since 1950 there has been a major destabilizing innovation in nuclear weapons technology. As long as research, development and testing go on in nuclear weapons technology, there is no reason to expect any change in this rate of destabilizing innovation. Thus the heart of the problem is research, development, testing. This brings us back to the SALT talks with the question, "Will the talks effectively limit research, development and testing in nuclear weapons technology?"

The answer is that it is highly unlikely that any limit will be put on R&D. That subject is apparently not even being seriously considered at SALT. There is a very small possibility that some limit might be put on the testing of MIRV. But, as I argue later, even this is unlikely. One reason for my pessimism is the recent tremendous emphasis of the U.S. Department of Defense on the importance of weapons research and on the existence of a research gap with respect to the Soviet Union. This is best illustrated by the following excerpt from a paper by J. S. Foster, Jr., in the "Defense Industry Bulletin."

> Today, while our research and development level of effort is now smaller, we believe that the United States is still technologically ahead of the Soviet Union — ahead on quality of weapons — by perhaps two or three years on the average. If present trends continue, however, the larger and increasing Soviet effort could result in the following:
>
> The Soviet Union could assume technological superiority in military research and development in the latter half of this decade. This superiority might be observable by the mid-1970s through the appearance of unexpected prototype military systems which, if produced, could make major U.S. weapon systems obsolete in the late 1970s. Their new missile silos may be an early first example of results of the incremental Soviet effort.
>
> Loss of U.S. technological superiority would markedly reduce our understanding of the intelligence we do collect and, as a result, seriously impair our confidence in our ability to make decisions about future weapon systems.
>
> Present relative trends in quality, coupled with the comparable trends in quantity — indicated by relative numbers of improved weapons deployed — would seriously jeopardize the U.S. margin of security in the 1975-85 time period.
>
> Recovery from such a loss of U.S. technological leadership would require enormous expenditures over many years — years of grave risk to our national margin of safety.

Thus it appears that threats to our deterrent forces from the building of Soviet nuclear weapons are being replaced by threats to our deterrent forces from Soviet research on nuclear weapons. These new types of threats are most insidious because they are difficult to answer and because they easily lead to instabilities in the arms race. It is very difficult to verify the claims of our Department of Defense about what nuclear weapons research is being done in the Soviet Union. It is hard enough to verify the claims of DOD about what the Soviet Union has actually built.

Because I have used the DOD example does not mean that I take them to be the only villains. If the Soviet Union's equivalent of the "Defense Industry Bulletin" were available to me, I am fairly sure that I could find a set of quite similar quotations. There is little doubt that R&D in nuclear weaponry is pursued as actively in the Soviet Union as it is in the United States and that their fears about new weapons are similar to ours. We seem, however, to be ahead by two to three years in much of this R&D, so we usually are the first to introduce the new weapon or weapon system.

The proposal has been made that it is only necessary to ban the testing of all missile delivery systems for nuclear weapons. It is argued that such a ban, particularly if it took effect soon, would stop the further development of MIRV and of ABM systems. This in turn would stop the extensive installation of new systems using MIRVs or ABMs. This proposal is accompanied by the contention that the continuation of R&D on nuclear weapons is not only to be allowed — it is to be encouraged. The claim is made that by continuing to do extensive R&D on nuclear weapons, both sides will always know what is technically feasible. Therefore both sides will know what to expect in the future and there will be no destabilizing surprises.

The proposal that nuclear weapons R&D be continued and strengthened is closely related to the second illusion. First, as I argued above, weapons R&D is basically a destabilizing activity. It is an activity which constantly raises threats to the safety of our deterrent forces and constantly raises fears about the safety of those forces. These threats and these fears need not be closely connected with reality; they need only be connected with symbolism and mystique which surround the deterrent forces. And, as I have already noted, we can easily threaten

From Figure 2 it can be seen that, ourselves through the all-pervasive fear that if we make a destabilizing discovery, the Soviet Union will also make that discovery.

Second, there always exists the possibility that continued research and development will lead to a new non-missile weapon which on an objective basis is destabilizing. Such a weapon might be offensive or defensive. An example would be the invention of an ABM system using lasers or other electromagnetic radiation. Such a defensive weapon would immediately destroy all three pillars of the deterrence concept. Such a weapon could be thoroughly tested even under the proposed ban on missile testing.

### *Third Illusion*

The third illusion takes two slightly different forms. In the first form it is acknowledged that SALT will not achieve its major objectives: stopping the nuclear arms race, starting nuclear disarmament, reducing the probability of nuclear war. But it is claimed that the narrow agreements which will be achieved still represent substantial progress toward those objectives because of three beneficial long-range effects of these narrow agreements. These effects are (1) the slowing down of other aspects of the nuclear weapons race, (2) the providing of a "breathing space" in which further negotiations can be started and (3) the production of a better international atmosphere for broader negotiations on nuclear disarmament. In brief, SALT is regarded as a substantial step in the right direction. The second form of the illusion has a tougher appearance. It is regarded as naive to believe that the major objectives of the talks are those stated above. Those major objectives are just part of the necessary publicity surrounding the talks. The real objectives are simply to produce a few narrow agreements, which will then have the three, beneficial, long-range effects listed above.

Thus both forms of the third illusion contain the beliefs that narrow agreements on nuclear weapons can slow down aspects of the nuclear weapons race and can provide a "breathing space." Unfortunately the historical evidence contradicts these beliefs. Past agreements related to nuclear weapons technology have had little effect on the pace of research and development in nuclear weapons technology, very little effect on the rate of introduction of innovations in weapons technology and no effect on weapons technology not covered by the agreements. These points are best illustrated by considering the Test-Ban Treaty of 1963 which dealt with atmospheric testing. As shown in Figure 2, the rate of introduction of new and destabilizing nuclear weapons systems was not affected by that treaty. The effect of the Treaty on the pace of nuclear weapons research may be assessed from Figure 3. The United States has conducted more nuclear weapons tests per year since 1963 than were conducted per year from 1951 to 1963. The Soviet Union as usual is behind, but not far behind.

Yet one of the arguments for the Test-Ban Treaty was that it would slow up the development of nuclear warheads, underground testing being so difficult. That clearly was not the case. In fact the Test-Ban Treaty was apparently only approved by the military in the United States when they were assured that it would not effectively limit research, development or testing of nuclear warheads.

I expect no more from SALT than from the Test-Ban Treaty because the SALT talks are being conducted by the same diplomatic methods as were used in the earlier negotiations. There is the same emphasis on petty maneuvering and on minor technical questions. There is the same intrusion of other international problems. There are the same controlled leaks to the press. There is the same almost paranoid cautiousness on both sides. There is the same worry about internal politics. The entire atmosphere is more suitable to a 1920 negotiation on naval limitations or Balkan boundaries. For these reasons, it is highly unlikely that SALT will lead to any slowing down of the rate of research, development and testing in nuclear weaponry. In this most important aspect the SALT talks have already failed unless the atmosphere, negotiation methods and real goals are drastically changed. This I consider a very remote possibility.

It is also highly unlikely that SALT will result in the scrapping of MIRV — the cause of the present instability in the arms race. As the talks go on, the United States is installing both land-based and submarine-based missiles of the MIRV type. The Soviet Union is a few years behind. It is inconceivable that the Soviet Union should agree to the United States alone possessing MIRVs. It is almost equally inconceivable that the United States will agree to dismantle its MIRVs. As I have already mentioned it has been suggested that a halt in the testing of MIRV and other missile systems could be negotiated at SALT. This would leave the United States with two partially tested systems, Minuteman III and Poseidon. It would leave the Soviet Union with one or more untested MIRV missile systems. I do not believe the Soviet Union would agree to being permanently behind the United States in MIRV technology.

The only agreements likely to come out of SALT are those which relate to aspects of nuclear weaponry about which neither side cares. For example, a limitation on ABM construction is possible because neither side knows how to construct an adequate system. A limitation on the number of land-based ICBMs is possible because neither side cares to spend the money to increase substantially this part of their deterrence forces, and small increases are not even symbolically meaningful.

The third belief associated with the third illusion is that narrow agreements attained at SALT would lead to a better international atmosphere for broader negotiations on nuclear disarmament. But this belief is also contradicted by the historical evidence. Seven years elapsed between the signing of the 1963 Test-Ban Treaty and the start of the SALT talks. In those seven years the number of nuclear weapons and nuclear weapon systems increased enormously; the very destabilizing innovation, MIRV, was brought to fruition; and if it had been technically feasible, large ABM systems would have been built. Thus there are no historical reasons for expecting that narrow agreements reached at SALT will be any more effective in the production of broader and deeper agreements on nuclear weapons.

In the introduction I described the third illusion as perhaps the most dangerous. The danger is most easily understood by considering again the Test-Ban Treaty. Many members of the American scientific community worked for years for that treaty. They were enthusiastic and optimistic when it was concluded. They then relaxed and assumed that normal governmental and diplomatic processes would lead to more extensive treaties and to more progress toward nuclear disarmament. Instead the reverse occurred — the arms race escalated. Even the public and political forces, built up during the campaign for the treaty, were dissipated. In many ways the struggle for nuclear disarmament was set back, not advanced, by the Test-Ban Treaty.

If SALT leads to only a few narrow agreements, the same dangerous situation will arise. Political and public pressures for nuclear disarmament have built up again in the last five years, partly through the anti-ABM campaigns. But mostly they were built through alliances with the conservation and anti-war groups. Therefore much of this pressure is not directly concerned with nuclear disarmament and can be easily dissipated. This dissipation is most probable if the American scientific community holds to the third illusion.

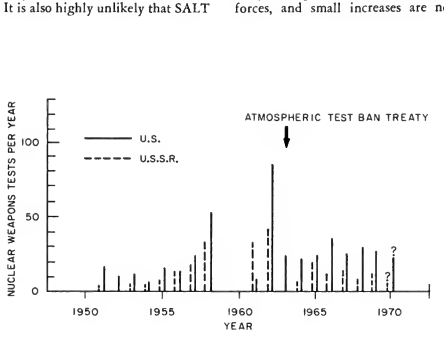



FIGURE 3

# Japan and the World of SALT

RYUKICHI IMAI

*"Japan's interest is in the durability of a SALT agreement. The day such an agreement loses its effectiveness can be the day NPT world order collapses. There is always a chance that either accidentally or deliberately the world of SALT will become inoperative and nuclear weapons will be used to kill people and to destroy cities."*

*Ryukichi Imai is a consultant to the Japanese Foreign Ministry on nuclear energy and is assistant manager of the engineering department of the Japan Atomic Power Co., Tokyo.*

On the whole, Japanese interest in the Strategic Arms Limitation Talks is rather vague. Newspapers and intellectual magazines carry occasional articles to report on the status of the meetings, but rarely with any in-depth analysis of what these negotiations might mean to the future of Japan. Instead of a sense of participation, the most one detects is a feeling that "it would be quite unbecoming if we didn't have an opinion or two on a subject as important as SALT."

In addition to the feeling that SALT is a matter between two superpowers, one important reason why the Japanese cannot become enthusiastic about it is the fact that Japan is an Asian power. SALT, in this sense, is primarily a European subject. Throughout the past quarter-century, the Japanese have never actually experienced the clash between the two nuclear umbrellas, have never lived in the midst of strenuous confrontation between NATO forces and Warsaw Pact armies. In spite of Korea and Taiwan, a direct threat of imminent nuclear war has not been a part of their daily concern. SALT, to the Japanese, is a subject, like mutually balanced force reduction (MBFR) in Europe, which is important but remote. Okinawa represents a much bigger issue.

Geographical separation of the Japanese islands from the rest of the world, as well as physical, cultural and linguistic distance from European and American centers of power politics, have traditionally been the cause of such an attitude. Similarly, one must recall that Japan, since the end of World War II, has been out of touch with the realpolitik of the nuclear world. As a defeated nation, Japan has regarded itself as a sort of second-rate citizen, without power to influence others in shaping the postwar world.

Meanwhile, the technology and politics of nuclear weapons have grown to cover a very wide and complicated spectrum. At one end of this spectrum are the sophisticated strategic arms. There are hosts of tactical nuclear weapons which may be as powerful as the bomb dropped on Hiroshima but so easy to use that foot soldiers may handle them on the battlefield. Nuclear-propelled submarines are not nuclear explosives, but there is no doubt that they constitute an essential part of the strategic weapons system. Thus the dividing line between a submarine engine and a nuclear power station becomes rather thin. The same problem exists on the issue of enriched uranium supply capacity in which Western Europe and Japan want to become at least partly self-sufficient and independent of the United States. There are also such things as the Rover nuclear rocket and Plowshare underground nuclear explosion for recovery of natural resources.

At the same time, very rapid and bewildering changes in international politics are taking place, as exemplified in the move toward a U.S.-Chinese detente and the very disturbed reaction of the USSR to President Nixon's "I will go to China" declaration. Changes in both areas — politics and technology — are intricately related, and SALT, in a sense, represents the height of sophisticated interrelationship.

One has to be a real "pro" to appreciate all these intricacies and be able to comment intelligently. One must have a command of all the inside languages and know the past history of negotiations. The Japanese today are at a very different stage of the game. They are in the process of modernizing their view of the nuclear world from harrowing memories of Hiroshima and Nagasaki to one that better suits the realities of the 1970s. It would be natural if they felt less than qualified to float freely in the clouds of expertise which surround the subject of SALT.

### *SALT and NPT*

It is possible to argue that SALT, and not nuclear disarmament or a complete test ban, is the natural outgrowth of the nuclear Non-Proliferation Treaty (NPT).

The world of NPT is divided into five categories of nations: two superpowers, two medium-size nuclear weapon states, China, nonnuclear weapon states that count, and those which do not count. Acceptance of NPT is a pledge not to challenge this

world order for some time, and has somewhat less to do with whether countries may or may not eventually possess some sort of nuclear explosives. The latter is a corollary to the former. Japan, in this sense, is already a full-fledged partner in the NPT world system. (Imai, "The Non-Proliferation Treaty and Japan," Bulletin, May 1969.)

### *Flexible Response*

It is evident that military capabilities of the two superpowers are so far ahead of the rest of the world that it is inconceivable for any third country seriously to contemplate military conquest of either the United States or the Soviet Union. As long as the two countries can maintain the posture of flexible response, nothing is more natural than that they would seek agreement mutually to limit further deployment of expensive and sophisticated strategic weapons. We may be thankful that the two countries are not so stupid as to escalate indefinitely nuclear rivalry, but no country would feel obliged to thank them for their SALT negotiations.

After all, they are talking about antiballistic missiles (ABMs) and multiple independently targetable reentry vehicles (MIRVs) which can be meaningfully employed only against each other. None of the third countries has been able to manufacture and deploy these sophisticated weapons. Unlike, NPT, SALT is a very exclusive affair between the two and is not the direct concern of multilateral negotiations such as the Disarmament Conference in Geneva. There should be eventual agreement of some sort, but it is also evident that such an agreement will never include surrendering the advantages the two possess of large-scale nuclear armament vis-a-vis each other or any third country. In fact, the United States and Russia will do their best to retain whatever direct influence their nuclear weapons may have in addition to their psychological deterrent effects.

Japan's interest is in the durability of a SALT agreement. The day such an agreement loses its effectiveness can be the day NPT world order collapses. There is always a chance that either accidentally or deliberately the world of SALT will become inoperative and nuclear weapons will be used to kill people and to destroy cities.

Beyond that, there can be two major factors to influence SALT's durability. One is a possible role for China now that she may become a formal participant in a nuclear round table conference. Even if China cannot achieve the U.S. or USSR level of a technical sophistication, it is conceivable that a tri-polar rather than a bi-polar military world could develop. China may acquire sufficient nuclear capability to make her another center of nuclear deterrence, with political interests which are independent of either superpower. Unless China is deeply committed to the paper tiger theory of nuclear weapons — and currently there is no indication that she is — she may have no choice but to become the third pole of a new tri-partite balance, or be relegated to the class of medium-size powers with limited influence in Asia.

### *Without an Audience*

The other factor which may possibly alter the significance of any SALT agreement is that the large overkill capabilities of the superpowers will become ineffective as realistic military strength. The contest for supremacy of first-strike or denial of second-strike capabilities is already becoming so theoretical that even today it is meaningful only among a handful of experts. In fact, without further sophistication, it is difficult to imagine a situation in which either U.S. or USSR leadership would deliberately attack with strategic nuclear weapons. It would be equally difficult for them to justify use of such weapons against a third country without risking nuclear world war. Within the NPT world order, the only nuclear action either country could take would be a concerted police action to subdue genuine subversion. Under these circumstances, warning of nuclear sanction should be sufficient as long as such warnings are credible. SALT may then become not only a negotiation with exclusive participants but also one without an interested audience.

Unless we assume that the world of SALT will remain unchanged forever, its last day may come about in several different ways. The world may achieve another SALT-type order among the three military centers. This may be the equivalent of China joining the NPT. Or the world may outgrow SALT and achieve a new realm in which strategic nuclear weapons can no longer be a meaningful restraint to keep world order. Its significance will vary, depending on whether SALT becomes ineffective, in which case chaos may again rule the world. In that case, economic strength with a tacit implication of weapons capabilities may shape the new world order.

Apart from a natural human inclination to conquer one's neighbor and thus maintain one's own security, it is economic prosperity the nations of the world seek. Prosperity assumes commitment to the existing order. Recent U.S. attitudes on matters of world trade and world monetary balance may express her understandable frustration that the huge post-war investment in military build-up is now producing a diminishing return throughout the world, either in terms of economic gain or political influence.

In terms of the foregoing analysis, the specific provisions of any possible SALT agreement will be important, yet not of immediate concern to the average Japanese.

### *Okinawa Issue*

Japan's main interest today is her future role in the politics and defense of East Asia. This became a very acute issue with respect to Okinawa. More directly, it began with the problem of whether the United States would continue to base several hundred tactical nuclear weapons in the islands after they were returned to Japan. The treaty for the return of Okinawa refers to this subject very indirectly only in its financial clause. Secretary of Defense Laird is said to have admonished the Japanese government to the effect that as long as Japan depends on the American nuclear umbrella for her national security, she should not fuss about where U.S. nuclear weapons might be stationed. The proper role for Japan, as expected under the Nixon Doctrine, is to strengthen her conventional forces, according to the same report.

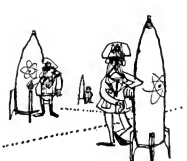
This posture has produced hosts

of arguments in Japan. What do we provide defense against, especially in view of a U.S.-Chinese detente? What is the American nuclear umbrella to Japan, and will it disappear if we refuse further cooperation with the United States? What expectations can we have for the Japanese-American Treaty? In this context the most serious question is: "Should Japan strive to become a nuclear power?" The answer to this is "no," for the following reasons:

1. Japan is building up a powerful nuclear industry. It is expected that by 1985 nearly one-third of her electrical power will have to be supplied through nuclear means, and this represents very large-scale industrial capacity, second only to the United States. But this industry will be dependent on foreign sources. Particularly, all uranium must be imported from abroad, and all enriched uranium from the United States, for at least another decade — probably longer. Major reactor manufacturers and fuel fabricators are under U.S. license, and a good deal of industrial technology will continue to rely on America. It is not possible for Japan to embark on peacetime nuclear weapons activity without invoking intervention of major supplying countries and thus risking the basis of her entire nuclear industry. The only weapons activity that Japan can engage in under the present system is a crash program against imminent danger, and with the tacit approval of major suppliers of nuclear material and nuclear technology. This is a situation already provided for in Article X of NPT which says that parties have the right to withdraw from the Treaty when the supreme interests of countries have been jeopardized.

2. High population density and heavy concentration of industries in small islands make Japan very vulnerable to nuclear attack. If possession of any nuclear weapons leads to an even higher possibility of Japan becoming subject to retaliatory or preemptive strategic nuclear attack, it has to be avoided by all means. On the other hand, the benefit to Japan of attacking any of her neighbors with strategic nuclear weapons is nil, especially in view of possible counter-attacks.

3. The technological gap created by 25 years of continual investment in weapons R&D by the United States and the USSR is very large. It will be impossible, no matter how favorable other circumstances may be, to build up a complete set of strategic nuclear weapons, delivery system, nuclear submarine fleet, military satellites, and so on. Even the entire Foruth Five-Year Defense Program cannot support a strategic nuclear force on the American scale for more than four months. Such nuclear weapons as Japan's technological and industrial level can realistically maintain will not allow her to influence the military balance of the world. And even if there were means to develop small or tactical nuclear weapons of a defensive nature alone, Japan has no land border to defend with them. It would take considerable worsening of the political climate before any country finds it beneficial to launch a military attack on Japan and to destroy her industry. There should be sufficient lead-time before the situation gets to such a stage.



4. If the guiding principle of Japanese nuclear policy is to react against the external threat of nuclear attack from her neighbors, and as the only use of nuclear weapons for Japan is to provide deterrence through fear of possible nuclear retaliation, then an expanding basis of peaceful nuslear industry and technology is a sufficient guarantee. Potential industrial capability will be enough to permit some sort of crash program if the need really arises, and Japan has sufficient assurance of expanding potential with the expected growth in a peaceful nuclear program. In the world of NPT, this recognition in itself provides sufficient deterrence without having to turn the potential into expensive reality.

In this regard, Japan does not lose any "nuclear option" by joining NPT. If this point is well understood, then expansion in peaceful nuclear industry, including uranium enrichment, fuel reprocessing and plutonium utilization should not alarm either Japan's neighbors or her own countrymen.

This means, at the same time, that Japan is in a very good position to appreciate the full social implication of nuclear technology and to have a correct perspective of its peaceful and military aspects.

### *Safeguards Concern*

One area of strong concern in Japan, in relation to NPT, is "safeguards against diversion of nuclear material from peaceful uses to military purposes." Article III of the Treaty obliges all nonnuclear weapon states party to NPT to accept such safeguards through agreement with the International Atomic Energy Agency in Vienna.

Technically, safeguards consist of (1) design information to be submitted regarding all peaceful nuclear facilities, (2) records of operation and movements of nuclear materials to be kept at each such facility, (3) reports to be submitted periodically about daily records and (4) inspections to verify that the first three are correct. Such inspections can be continual in nature and unannounced, and may eventually claim access to all and any part of the facility.

From June 1970 to April 1971 an international committee was convened in Vienna to discuss how safeguards under NPT should be operated. Some 50 countries sent representatives to participate in the discussion. A good deal of argument centered around an effort to find optimum technology to achieve maximum effectiveness with the limited financial and personnel resources available to the International Atomic Energy Agency, and yet without infringing upon commercial secrets or peaceful nuclear industry. Nonnuclear weapon states have been vitally concerned that the safeguards should not create undue inequality between their industry and that of

the weapon states which are under no obligation to accept safeguards. There have been a great many delicate points — technically, politically and legally — which various delegations argued during the committee sessions.

Through the combined efforts of the Vienna committee and technical experts from various countries, safeguard procedures have been improved and made more suitable vis-a-vis the actual developments in nuclear industry. Yet these procedures are still largely subservient to the monolithic position that aims to decide the future course of this important technology by looking at its military possibilities only. It is somewhat like an attempt to prohibit the use of the plough because it may be transformed into a sword.

Because of the past history of weapons development, there are many who can see the problem only from this angle. The nuclear-weapons states in particular are often preoccupied by the military phase of nuclear technology, although they were the first to recognize its historic importance when they proposed the first U.N.-sponsored Geneva Conference on Peaceful Uses of Nuclear Energy in 1955, and started a campaign of technical assistance on a worldwide scale. Unfortunately, such signs of initial enlightenment became obscured as the world faced the nth country problem. Yet this aspect of the safeguards issue is perhaps more important in the long run than the political and technological inequality which Article III has imposed on certain countries.

In considering the social implications of nuclear technology, we should keep in mind that there are two sides to the coin.

On the one hand are the great benefits which are promised for the advancement of human welfare. Not only does it bestow a virtually unlimited source of energy as well as industrial and medical applications, but its advancement also carries with it progress in various associated technical fields such as modern materials science and electronics. This is why Japan has insisted that international exchange of technological information in the nuclear field should no longer be restricted for reasons of national security. Under the NPT system, safeguards provide assurance of nonmilitary application of technology as far as this is possible, and exchange of technical information should be governed only by normal rules including consideration of its commercial value. This is how Japan reads Article IV of NPT.

### *Environmental Risk*

At the same time, it is now well appreciated that any large-scale advancement of science and technology carries with it a certain risk of adversely affecting our natural and social environment. Problems of sulfur oxides, pesticides, automobile exhaust and the supersonic transport (SST) are well known issues which indicate the complex relationship between technology and society.

In the nuclear industry, possible contamination by long half-life fission products presents another important problem. High level radioactive wastes have to be permanently secluded either in salt mines or in the ocean's depths under very careful control. Similarly, it is necessary to monitor the effects of increasing gaseous radioactivity in the atmosphere. This type of control obviously requires close cooperation among countries. An international system of control and surveillance will be increasingly required as the worldwide nuclear industry continues to develop.

Safeguards against military diversion are also a requirement, if we are to protect society against adverse effects of a nuclear technology that had escaped rational control. Anyone who has read or heard about the suffering of the bomb victims at Hiroshima and Nagasaki would want to look at the problem as a matter between overgrown technology and feeble humans before indulging in the sophisticated politics of strategic nuclear weapons. Since NPT, moreover, there is much less need to worry about frontal challenge to the established world order by a nation with powerful strategic weapons. Such an action would be preceded by significant changes in the international climate which should certainly be detectable without IAEA inspectors. It is not a part of the function of IAEA safeguards to read political writings on the wall.

The greater concern lies with the possibility of a less sophisticated and cruder challenge by powers who have less stake in the existing order. It may come, for example, from a state having a very small number of elementary atomic bombs. Claims for recognition by such powers, even with untested bombs, would be equally disturbing. There is also the possibility of a nuclear threat within a nation — from the Mafia or from guerrillas, for example — if they demand political ransom by threat of small-scale nuclear attack. Instead of playing an unrealistic technical game of locating the last gram of plutonium within reactor cores, international safeguards really should be concerned with these types of problems.

Similarly, there is the matter of thousands of tactical nuclear weapons spread around the world by the superpowers as a part of their military system. Should they ever be misplaced and inadvertently fall into the hands of irresponsible persons or organizations, danger to the world will be very great. Means of international assurance to prevent such accidental happenings by providing credible systems of physical and administrative control on all types of nuclear weapons is at least as important and necessary as NPT safeguards. By submitting themselves to an international control and assurance of this nature, nuclear weapon states can demonstrate to the world that their concern in this area is not just narrow self-interest.

If SALT is a natural extension of NPT, then in the Japanese view, recognition of these principles of international control and immediate action to establish such control is a matter of universal and practical importance. It will be as important as a declaration of non-first use of nuclear weapons, and more feasible than universal acceptance of a complete test ban and its enforcement. Japan, it seems to me, will then be more than willing to embrace the Non-Proliferation Treaty in its entirety and to give its blessings to the outcome of the Strategic Arms Limitation Talks.

# SALT AND INTERNATIONAL SECURITY

*This report is excerpted from the Statement by the Pugwash Continuing Committee, following the 21st Pugwash Conference on Science and World Affairs Aug. 26-31, 1971 at Sinaia, Rumania. The conference was attended by 97 scientists from 31 countries and nine observers from five international organizations.*

The past year has seen some positive developments — an encouraging statement by the USSR and the United States on the further program of SALT and the successful elaboration of a draft treaty banning biological weapons (BW). But the arms race continues to outpace by far the progress in arms limitation and disarmament.

There is an urgent need for measures, partial or general, which will be more effective than those taken hitherto in slowing down the arms race and achieving disarmament.

The Group's considerations reflected its agenda, with emphasis on the limitation and elimination of mass destruction weapons. The discussants were fully aware, however, of the dangers inherent in the conventional arms race, the existence of military blocs not only in Europe but also in other parts of the world, arms traffic, etc., and considered it important that due attention be paid to all these problems.

### Matters Related to SALT

It is hoped that the SALT conference will bring some significant results before the end of this year. Prompt and substantial results in this area are a prerequisite for progress in other areas of disarmament, especially the further expansion in the number of adherents to the NPT and its effectiveness. Such progress will also have beneficial effects on other disarmament measures, such as on European Security, limitations of conventional forces and weapons, and other measures leading towards the final goal of general and complete disarmament.

Specifically, the negotiating parties at SALT are urged to achieve an agreement which would severely limit the deployment of ABM, preferably at the zero level. The zero level was considered to be far preferable to any other because it avoids any questions about qualitative differences and hidden growth potentials and thus removes the last vestige of any stimulus for the further arms race not only in anti-ballistic missiles (ABMs), but to a substantial degree in the field of offensive weapons also. Any possible advantages of a severely limited ABM over a zero ABM do not seem to outweigh the dangers of a continuing arms race.

The negotiating parties at SALT were also urged to achieve a meaningful limitation on offensive weapons in order to stop the arms race immediately and to make it possible to begin the process of substantial arms reduction soon after. Such substantial arms reductions may be more difficult to negotiate, but they are absolutely essential if real world security is to be accomplished. It was emphasized that, in addition to limiting and reducing numbers, it will also be important to make provision for controlling and limiting qualitative features of weapons so that the arms race cannot be simply shifted in this direction. Qualitative features include size, multiple warheads, accuracy, etc. It was suggested that one good means for accomplishing this last objective would be a severe limitation on the rate of missile test launches, including confidence launchings.

This process can and must proceed on the premise that equal consideration is given to the security interests of each party and that neither seeks to obtain unilateral advantages.

Disarmament negotiations also must give attention to limiting or, better, avoiding an arms race in new areas. In this connection the problem of anti-submarine warfare (ASW) was discussed, and it was pointed out that ASW research and development aimed against missile-bearing submarines is research and development on counterforce techniques. Such efforts could be taken by either party as indicating preparation for a preemptive attack by the other, and thus can be very destabilizing and can stimulate further arms races in unpredictable directions. An ASW limitation would therefore greatly facilitate the achievement of agreements to reduce substantially the numbers of long-range delivery vehicles.

### Comprehensive Test Ban

Preventing further vertical and horizontal proliferation of nuclear weapons remains extremely important, and the achievement of a comprehensive test ban treaty will make a major contribution to that end.

Fortunately, progress in the development of the means for detecting possible violations has effectively removed the obstacles which once blocked the achievement of such a treaty. These means include not only seismic methods for detection and identification of nuclear explosions but also satellites and other unilateral means for collecting information. The combination of all these techniques now makes it practically impossible to conduct meaningful nuclear testing without detection.

In the process of preparation and putting into effect of such a treaty, it is most important to include at an early stage all the nuclear nations; it is also important to involve other nations, especially those that have the capability of becoming nuclear powers in the near future.

In this connection the problem of so-called peaceful nuclear explosions was also discussed. The conclusions reached at the last Pugwash conference were reaffirmed: "Excessive claims have been made regarding the importance of nuclear explosions for peaceful purposes. Whatever short term economic advantage there may be in the use of such explosions is likely to be more than offset by the risks of nuclear proliferation implicit in such explosions."

### Non-Proliferation Treaty

It was noted with satisfaction there has been no nuclear weapon proliferation for the two and one-half years since the Non-Proliferation Treaty was first signed. Even so, the great importance of formal accession to the Non-Proliferation Treaty was affirmed and all nations that have not yet done so were urged to sign and ratify it at the earliest possible date.

At the same time, there was an awareness that the continuing effectiveness and durability of the treaty demand substantial progress in inhibiting vertical proliferation by real progress at SALT, adoption of other measures of self-restraint by all the nuclear powers, and agreement on the comprehensive test ban treaty.

### Chemical and Biological Warfare

**Geneva Protocol.** It was noted with satisfaction that there are now 96 parties to the 1925 "Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases and of Bacteriological Methods of Warfare." The United States is the last militarily important country which is not a party to it.

In the United States the Protocol was recently resubmitted to the U.S. Senate for its consent to ratification. It was resubmitted with a letter stating the United States' interpretation that the Protocol did not apply to the use of tear gas and herbicides in war. The chairman of the Senate committee responsible for the treaty replied with a letter asking for reconsideration of this interpretation, and it appears that such a reconsideration is now going on. It was urged that the United States withdraw its interpretation excepting tear gases and herbicides and become a party to the Protocol. The United Kingdom was urged to withdraw its interpretation excepting CS tear gas from the prohibitions of the Protocol.

**CB Disarmament.** A major issue in the field of CB disarmament has for a long time been whether chemical and biological weapons should be got rid of together or whether a treaty outlawing possession of biological weapons only, would be a productive first step to the eventual elimination of both. During the past year the issue was settled in favour of action on biological weapons only.

President Nixon unilaterally renounced development and production of biological weapons and toxins and undertook to destroy the U.S. stocks of these weapons. The socialist countries, which previously had tabled a draft treaty on chemical and biological weapons, tabled a draft on biological weapons only. After a relatively short period of negotiation, a revised draft has now been agreed and submitted to the CCD by the socialist countries and the United State.

The draft treaty would not prohibit research to improve defenses against biological weapons, such as the preparation of vaccines for inoculation against germs which might be carried by such weapons. It was recommended that secrecy be eliminated from research of this kind as a protection against its being carried further than the production of vaccines, and to minimize the suspicion that may be provoked by this kind of work.

**Chemical Weapons Disarmament.** There is a grave risk that the achievement of a biological weapons treaty will lead to a relaxation of efforts to achieve a chemical weapons disarmament treaty, and thus leave untouched what is undoubtedly from a military point of view the most important part of the CB-weapons field. The draft biological weapons treaty explicitly provides that negotiation of a chemical weapons treaty should be pursued, and the nonaligned nations have been trying to strengthen this obligation. Progress to a chemical weapons treaty is imperative if chemical weapons are not to become a tacitly endorsed item in national armories.

The obstacle to chemical weapons disarmament has been disagreement whether international verification of nonpossession of chemical weapons is needed and is possible.

The suggestions made at the Geneva Disarmament Conference, for a verification procedure not unlike that provided by IAEA safeguards, were noted. Such a procedure would combine a national chemical safeguards system with international audit and spot checks. The objective should be to achieve an overall system which would deter significant violations with as little intrusion as possible.

There were different views in the Group on the need for international verification rather than reliance on national means. There were also differing views as to whether verification was the real point of disagreement.

### Tactical Arms Limitation

The reduction of nuclear arms in Europe is of very great importance, both from the point of view of European security and as a substantial step in the general efforts for disarmament. To that end, the following was offered:

*A Specific Proposal for Tactical Nuclear Arms Limitation in Europe, designed to serve as a first approximation for further discussion.*

a. No Foreign Nuclear Weapons in any European country. Delivery systems which are useful only when outfitted with nuclear warheads should be similarly prohibited. This in effect means denuclearization of Europe from the Rhine to the Soviet Border.

b. United Kingdom and French nuclear weapons should be limited to those now deployed, or currently in the process of being deployed. No distinction between "Tactical" and "Strategic" deployments or uses should be made in this case.

c. Soviet MRBMs and IRBMs which are located so as to be capable of striking Europe should be limited to a number equal to the total number of British and French weapons deployed on long range missiles. Similar arrangements for medium range aircraft should also be made.

d. The Non-Proliferation Treaty and the Partial Nuclear Test Ban should be continued in force and expanded to the extent possible. All possible political means should be used to reinforce the treaties so as to prevent any further spread of nuclear arms in Europe.

e. If these radical reductions are to be achieved, there must also be a substantial and simultaneous reduction of conventional armed forces and armaments.

The simultaneous elimination of both military blocs — NATO and the Warsaw Treaty — or, as a preliminary step, the dissolution of their military organizations, thus putting an end to the stationing of troops on foreign territory and their maneuvers, the existence of foreign military bases, etc. — would be of great importance for European security and disarmament in Europe.

It should be understood that these proposals are not a final blueprint but show only the main direction which could lead to significant results in disarmament in Europe and improvement of the political situation in that continent.

It should also be understood that many particular items which have been ignored or overlooked here will become of importance during possible actual negotiations. These include the disposition of nuclear-capable naval forces and other similar questions. But it is hoped such further details could be readily solved if the negotiations are in the spirit and scope of the above proposals.

It was felt that this radical approach may have a better chance of working than the traditional piecemeal attempts to ensure precise balance in every field each time a small disarmament proposal is made. Bold actions seemed to be the only practical way out of the present impasse.

However, it was felt by some that the proposal is not a realistic one. The question was also raised as to whether entirely new standards and approaches, substituting for the concepts of military balance and deterrence, should be considered. It was emphasized by some that these traditional concepts have led only to an arms race.

### Disarmament Negotiations

There are important flaws in the present method of negotiating disarmament agreements. Some of these, and possible corrections for them, are discussed in the following paragraphs.

Two nuclear powers, China and France, are not now participating in any negotiating forum. Without them any real major disarmament is very difficult and general and complete disarmament is obviously impossible.

France should take her seat at the Geneva Disarmament Conference and contribute to disarmament again as she did so positively in the past.

China should participate in disarmament negotiations. States having formal diplomatic or informal political relations with China should urge her to do so.

Those countries which could achieve nuclear weapons capability in less than five years have insufficient opportunity to discuss the limitation and reduction of strategic nuclear delivery vehicles with the United States and the USSR who are talking about these matters alone in SALT. Also there is no link between the discussions of strategic nuclear delivery vehicles in SALT and the discussion of other kinds of weapons, both nuclear and conventional, in other forms.

In any case, since progress in other disarmament negotiations depends on progress at SALT, a close link is required between SALT and the other disarmament negotiations. Some of the discussants believed that SALT should become a subcommittee of the Geneva Disarmament Conference. Some others suggested that the United States and the USSR should make periodic reports to the Geneva Conference on progress made at SALT. Still others believed that the present system should not be disturbed at such a crucial time.

Some people believe that too much power has been exercised by the United States and the USSR as Co-Chairmen of the Geneva Disarmament Conference. They argue that a condition for the entry of France, and possibly China, into this Conference is the abolition of this co-chairmanship. Others feel that this Conference has been productive of a number of agreements and that the work of the Co-Chairmen has really facilitated this progress. They urge that an institution that has worked well in the past should not be abolished hastily or prematurely.

Finally, there was general agreement that a general disarmament conference should be convened in which all interested states could participate and express their points of view.

Successful progress towards disarmament, considering not only interim measures but also general and complete disarmament, requires a radical improvement of the international situation, the elimination of all hotbeds of war and sources of tension, the renunciation by all states of the use of force or threats to use it to resolve international disputes, and the strengthening of international machinery for the resolution of conflicts and keeping the peace.

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*Letter from London*

# NOTES ON SCIENCE POLICY IN BRITAIN

*by AURUM*

What is Lord Rothschild, director of the Central Policy Review Staff (CPRS), up to? That's the question those of us interested in science policy in Britain are asking with increasing frequency. Is he really the formulator of new policy, taking over the functions of other established personalities?

Briefly, the government's main science advisors are Sir Alan Cottrell, official science advisor to the Cabinet; Sir Brian Flowers, chairman of the Science Research Council; Sir Frederick Dainton, chairman of the Council for Scientific Policy; and Professor Hermann Bondi, advisor to the Ministry of Defense. Flowers and Dainton both report to the Secretary for Education and Science.

My guess is that Rothschild, Flowers and Bondi are at the head of the league. The Dainton report on Research Councils (Bulletin, June 1971) has been shelved, and Rothschild is now conducting an inquiry into the same subject. He is busy also in formulating a policy on R&D.

We know as a result of some hard questioning in the House of Commons that in August the CPRS had a staff of 24, including 11 secretarial and other supporting staff, but the names of only three of the key 13 are known. It is strange that the names and functions of the others have not been revealed.

The Prime Minister commented, rather mysteriously: "As to the members and salaries that they are paid, the names of the senior appointments were announced as they were made, as were the salaries they were to receive. Details of the rest of the appointments will appear in the standard works of reference."

What is clear is that the CPRS reports are not going to be made public. Mr. Heath has explained that the CPRS was created specifically as part of the Cabinet Office. "As this unit [it is known also as the central capability unit] is part of the Cabinet Secretariat, it would be quite wrong if the advice which it gives to Ministers were made public."

Clearly, this is not in the best interests of the nation. The top experts will be pre-empted by the CPRS: those who give advice will be bound to remain silent, and those who are not involved in this way may be disregarded as not knowing all the facts.

This is what Kenneth Mellanby, director of the Nature Conservancy's Monkswood experimental station, has been talking about. Since research councils have been put under the control of the Department of Education and Science, he states: "There has been a tendency for scientists to be told they must behave like civil servants and must not say or do anything which might embarrass their Ministers. This is dangerous, and could lead to a situation where only real experts, not bogus ones who so often hit the headlines, are prevented from speaking."

In this context, I recommend "The Politics of Technology," a little-known report (September 1970) by a Stanford University workshop on Political and Social Issues. The authors, Frank Von Hippel and Joel Primack, were "shocked" by what they discovered. "We learned that when advisors express concern about dangers inherent in policies pursued by the Executive, their reports have generally been suppressed, and have occasionally been misrepresented to the public and sometimes even to the President. We furthermore found that this suppression and public distortion was often coupled with an attempt to use the eminence of the expert advisors to buttress the case for the objectivity and nonpolitical nature of the decision."

By and large, this present Conservative government seems to be developing a more clear-cut approach to industrial research than did its predecessor, the Wilson government. Certainly, Lord Jellicoe, a most influential Minister, responsible for planning and the civil service, takes up a realistic and intelligent attitude.

He was involved in the decision to set up the central policy review body, which he believes can make a great contribution to improving the long-range planning aspects of government. He is insistent that government should look ahead.

To provide a new medical school, a period of over 15 years of forward planning is needed; a motorway requires 10 years for construction work alone; and in education, government planners are now deep into the 1980s.

Jellicoe has been much involved in battle with the Institution of Professional Civil Servants, the union in which 77 per cent of the higher-grade government employees are members.

William McCall, its energetic secretary, declares bluntly that the government's policy on incomes has clearly discriminated against the public sector. He is highly critical of the extent to which there is contracting out of research: "It is less efficient, and it is more expensive; and it is not a sensible way to reduce the size of the Civil Service."

The Conservatives' election pledge, by the way, was to reduce the civil service to below 500,000. This has been achieved. But everyone recognizes that it is pretty meaningless; merely a politician's carrot for the voting hoi polloi.

* * *

Interest is growing in this country in social indicators although,

typically, the British approach is pragmatic. We want hard answers to such questions as how to measure the effectiveness of existing policies in health or in education.

Earlier this year, the British and American Social Science Research Councils sponsored a joint get-together in Britain. No agreed answer could be given to the question of how far social indicators could be used for public policy purposes. This is mainly because there are still divergent definitions of social indicators, continuing methodological arguments as to whether or not the component statistical series should be aggregated, and whether it is feasible to expect governments to use any indicators which might be produced.

What was agreed by all was that we need to devote more resources to research in the U.K. In the United States, by contrast, the federal government, and bodies such as the National Science Foundation and the Russell Sage Foundation have available about $7 million this year for such work. This is double the sum which the British SSRC has this same year for the whole of its program in research.

* * *

The Open University is ready to begin its second year, which — as distinct from the Oxbridge-patterned October to June — runs from January 1 to December 31. Teaching takes place during the 36 weeks from January to October; November and December are reserved for examinations and subsequent course registration.

Anyone may apply to be admitted as a student, without any previous educational qualification. In 1971, 25,000 students were admitted. The numbers have been maintained.

Courses are provided at four levels. The first consists of the foundation courses. In the current year, these are in arts, maths, science, and social sciences. Next year, technology is to be added. In educational terms, the Open University may contribute something shattering to the curriculum.

The Dean of the Technology Faculty, Geoffrey Holister, is not primarily an academic. He has spent his life in industry. A "bon viveur" who makes his own wine "because we consume so much of it at home," he moved recently from a seventeenth century to a fourteenth century house because he felt the former was "too modern."

His approach to technology is that it cannot be treated as an afterthought; it must be seen to be rising from the fabric of our way of life. As a preliminary, he would like to have this outlook introduced into the secondary school curriculum, where technology has no place at all. It is too often merely an aspect of some miscellany called "liberal" or "social" studies. It is hoped that a conference, planned for December, may be a first step to this approach.

The Open University is funded directly by the Department of Education and Science (DES). The other universities are "cushioned" by the University Grants Committee (UGC), an odd body which derives its existence from a Treasury minute of 1919, and which, as everyone is aware, exists on sufferance from the universities and the government. Expansion proposals are submitted to the government, which decides on numbers and money. The UGC then divides it out.

The main UGC problem is to forecast demand for a decade ahead. Planning now is for those who will graduate in 1980.

Science and technology have been expanded rapidly, with provision of nearly two science places for every one in the humanities, so that there is about 57.5 per cent science capacity to 42.5 per cent arts. But the university student population is at present 55 per cent science and 45 per cent arts. There is, therefore, room for more science students.

The UGC is seeking to correct the imbalance by building six arts places to one science place in the next few years. At the end of the quinquennium 1972-77, plans are for a student population of 320,000. Will the balance between science and arts be right? Unfortunately, no one knows.

* * *

At a high-level dinner party in Leningrad recently, a foreign guest told a story: President Nixon had been kidnapped, and a message was received at the White House demanding $1 million immediately — or else he would be returned! The chairman laughed, and said, "Fine. But here we tell that story about Brezhnev."

## *ON THE CONTROL OF SCIENCE: FOUR VIEWS*

*Who controls technology? Who—or what agencies—determines priorities for technical development? Four highly qualified experts addressed themselves to these questions last April 12-13 at a Northwestern University Colloquium on "The Control of Science for Civil Needs." Their papers, analyzing questions of social control and direction of the techno-scientific revolution, are published herewith.*

# I. TECHNICAL POWER AND PEOPLE

## The Impact of Technology on the Structure of Government

*"Now, all of a sudden, people have awakened to the fact that science and technology are just the latest expression of power and that those who control them have become the new bosses, exactly as the feudal landlords who owned the land, or the capitalist pioneers who owned the factories, became the bosses of earlier generations. Ordinary people will not now be satisfied until they have got their hands on this power and have turned it to meet their needs." The Right Honorable Anthony Wedgwood Benn, M.P., is a former Minister of Technology and Minister of Power, United Kingdom.*

*ANTHONY WEDGWOOD BENN*

The structure of government within the nation state, as now organized, is unlikely to survive in its present form. It evolved in response to circumstances very different from those that now exist and, as is evident, it is proving itself incapable of coping adequately with the amount of power that mankind now has at its disposal. It is both too small to exercise really effective human control over the destiny of its own citizens in a tiny and dangerous world; and it is too big and too clumsy an instrument to deal with the rapidly changing and diverse needs and values of people in the communities where they live and work.

This is the inescapable conclusion to which one is driven by even the most superficial examination of the impact of the technological revolution through which we are passing.

This process of political obsolescence has been going on for a long time; and it began to accelerate with the development of weapons systems that extended the range of warfare beyond the heavy artillery and relatively light and slow aircraft which were in use up until World War II. With the advent of nuclear weapons and intercontinental missiles, the nation state was forced to surrender its basic claim, on the allegiance of its people — namely, that it served as a necessary and effective instrument for defending its citizens against assaults from the outside. Modern weapons led to the move towards the bloc system of defense which represents, even for the senior partners in each bloc, a permanent erosion of their national independence and sovereignty. And it was recognized at about the same time that the ultimate logic of modern weaponry required the establishment of some world organization like the United Nations, with the implication that one day it would develop into an embryonic world government, however long it took to reach that state. Meanwhile the paralysis of the superpowers when they try to use their military arsenals is only too apparent.

But it is not only the emergence of external forces that have brought into question the credentials of the nation state. Technology has had an equally dramatic impact on the lives of the citizens, in both less developed and highly developed societies. Their experience of modern life, amplified by the mass media, rendered more intelligible by improved education and made progressively more vulnerable and fragile by the interdependence that is inseparable from economic development, has led to demands being pressed from below which the modern state with a cen-

tralized power structure may be incapable of meeting quickly enough to avert intolerable strain, and possibly violent upheaval. Thus the second claim of the nation state that it can effectively protect a society against the risk of internal disorder or disintegration is also in doubt. Looking around the world the stresses in many countries can be seen to be dangerously above the safety level.

Nor is it only in terms of military or civil insecurity that the nation state has found itself on the defensive. Industrial development — especially by the multi-national corporations — far exceeds the scale of operation of industry a generation ago, and the power of these new companies, not to mention their rate of growth, now exceeds that of many nation states. Governments of even quite advanced societies can no longer, therefore, claim to be wholly effective in safeguarding the interests of their citizens against possibly harmful decisions taken by these firms.

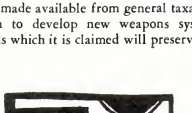
Moreover instantaneous worldwide communications available on more and more television channels means that the nation state can no longer guarantee to erect on its frontiers effective censorship that filters out unacceptable foreign ideas and preserves the sort of broad identity of views, culture and outlook that could be said to represent its way of life as embodied in the consensus on which its society worked.

The death-throes of the self-contained nation state may last for a very long time, but the process of transformation in the constitutional structure of society is as inevitable for the nation state as it is for any firm which finds technological change destroying its old management structure and requiring it to adapt itself accordingly.

The emergence of international managements controlling military and industrial power has now virtually ousted the shareholder or stockholder as a center of power and has simultaneously stimulated greater demand for popular power.

In this process the role of science in society has come to occupy a central ground of argument between the new bureaucracies that see it as an agent for promoting their own aims and purposes, and people who increasingly see science both as a threat to their survival and, if properly used, as one of the key instruments for solving the problems that press on them most directly. Thus science has been drawn out of the academic atmosphere from which it drew its inspiration and original funding, and into the vortex of political controversy.

Science as an instrument for political domination has given birth to the military-industrial complex which is immensely powerful in both the communist and noncommunist worlds. Enormous sums of money are made available from general taxation to develop new weapons systems which it is claimed will preserve




a favorable power balance for those nations that are ready to pay the bill and spare the necessary qualified manpower.

But meanwhile, from below, more and more voices are being raised to divert these same resources to meet the needs of development and to improve living conditions. It is not just modern war with its inevitable killing that is becoming unacceptable, but the growing conviction that war-making absorbs money and skill on such a scale that, were it to be turned to constructive purposes, the causes of many conflicts that lead to war might be eliminated.

The same tug of war is evident in civil industrial developments. The bureaucracies which govern large firms (sometimes supported by governments) are forever seeking to maximize their return on capital invested by using science to make more sophisticated products and by employing complex techniques of persuasion to create a demand for them; at the same time, the public is beginning to question the whole process. First, they are concerned with the side effects that may follow from the unchecked economic growth that has up to now been regarded as an unmixed blessing. Second, they are beginning to wonder whether there are not other needs to be met than those which express themselves through market forces. The conflict between private and public transport in major cities is one example, and the whole structure of educational provision with its tremendous concentration on graduate and postgraduate work is another.

National governments are caught between these two formidable forces which are pulling in opposite directions. They know — because it is their business to know — that large and efficient managements will be required if the delicate balance in any world system is to be maintained. To this extent they are necessarily in close and continuing contact with the big organizations concerned.

At the same time, especially in societies where the vote has been granted, national politicians are painfully aware of the pressures coming from their electorates conveying, however, imperfectly, the problems and aspirations of ordinary citizens.

National governments are thus the fuse box connecting two conflicting realities. A great deal of current passes through that fuse box, and the heat is intense. If it blows, there could be a total blackout and a total breakdown. President Truman once said: "If you don't like the heat, get out of the kitchen." But somebody has to stay in the kitchen at least until we can find a cooler way to cook.

Until recent years the centralized bureaucracies seemed to be having it all their own way. They generated technology, and controlled the use to which technology was put. The public was so astonished by the new scientific miracles and felt so humble in the presence of the experts in science and technology who masterminded these achievements that they hardly questioned the purposes to which this power was being put. Henry Ford was seen as a man who had put technology at the service of man. Military scientists were seen as key figures through whom security

could be achieved and our enemies vanquished. Technical decisions were uncritically accepted as lying outside the capabilities of ordinary people to question and they stood back while the experts decided. Thus it was that President Kennedy's historic decision to put an American on the Moon by 1970, or the Anglo-French Treaty to build the supersonic airliner, were accepted without public debate. Both these ventures were seen as glorious examples of man's freedom deriving from his new-found power to control nature.

But once freedom — in this case scientific freedom — had been won, people started to question how that freedom should be used. It may take a highly skilled chemist to develop a contraceptive pill or a brilliant engineer to develop a new system of communication. But the use to which either is put involves the application of a scale of values which it is entirely within the capability of everybody and anybody to apply for himself. The problems of the control of technology in a scientifically permissive society can therefore be seen to be no more complex than any other value judgment which democratic societies now accept and that electors and voters are qualified to take.

Indeed, there is now growing evidence that more and more people are quite independently coming to the same conclusion and this is expressing itself in more forceful demands from below. These demands are not new ones, but what is significant about them is that for the first time the technology capable of satisfying them now exists.

Take first the demand for sufficiency from those who are still experiencing poverty — both the poor in developed societies and the even greater number of poor in societies that have not developed. These people are different from their forefathers in that they know that other people have escaped from poverty and that the technology that made escape possible is available to them. It is one thing to be poor when there is no choice, but it is another to accept what may appear to be an unnecessary poverty. This is the cause of the revolution of rising expectations in both developing and developed societies. As living standards rise expectations seem to keep well ahead of them and produce the curious phenomenon of levels of personal dissatisfaction rising in parallel with affluence.

The demand for greater equality is also gathering force, similarly fanned by the mass media. This is not merely a demand for greater economic equality, but also for racial and sexual equality which sees in discrimination an entrenchment of unacceptable privilege and a perpetuation of a more fundamental oppression. The use of resources including scientific resources to secure greater equality is highly relevant, especially in the educational field.

The worldwide demand for educational reform touches directly on the control of science. More and more people are becoming skeptical of the established objective of education to educate elites, including scientific elites. Even if looked at from a purely practical point of view it would appear that the main barriers to human advance lie more in our failure to apply well-established techniques than in our tardiness in evolving new ones. For example, millions more lives could be saved by raising the general level of simple health services than by pouring millions of pounds or dollars into perfecting heart transplants or other sophisticated surgical operations. There is even a curious convergence of view between a community which doesn't quite know how to employ the many PhDs emerging from graduate schools, heavy with honors but short of experience, and the students who everywhere are discontented because their studies are so academic and appear to lack "relevance." This feeling is shared on both sides of the Iron Curtain and there are more similarities between modern thinking on this in China and the United States than there are between the old school academic establishments in both these countries and the communities they are supposed to serve. Educational bureaucracies are already finding themselves on the firing line along with the military industrial complex as this pressure begins to build up.

The demand for greater popular power — or participation as it now tends to be called — follows from the demands described above. Where the franchise has not yet been won, it is being demanded; and where it has been achieved, there is a mounting pressure for further democratization of decisionmaking.

This pressure is not really new at all. It is as old as political philosophy itself, but what is new is that it is being extended far beyond the simple demands of the Founding Fathers of the American Republic or the French Revolution, or the modest advocates of universal adult suffrage. More and more people are coming to suspect that democracy has slipped through their fingers while they were busy watching science proving its apparently limitless capability.

### *The New Bosses*

Now, all of a sudden, people have awakened to the fact that science and technology are just the latest expression of power and that those who control them have become the new bosses, exactly as the feudal landlords who owned the land, or the capitalist pioneers who owned the factories, became the bosses of earlier generations. Ordinary people will not now be satisfied until they have got their hands on this power and have turned it to meet their needs.

This may sound like a very revolutionary doctrine, and so indeed it is. But once we understand what is happening, it is no more frightening than the demand for power that emerged in the past as a popular clamor for political democracy.

What we lack are the institutions capable of realizing that demand in today's world, and making it effective. It must necessarily lead to the strengthening of international and supranational institutions big enough to encompass the totality of man's needs as he gradually learns that brotherhood has moved from a moral aspiration to an essential prerequisite of survival. We are mainly short on imagination bold enough to extend our sense of responsibility to embrace the area of our common interest. This imaginative leap is difficult for the old and the middle aged, but it comes quite naturally to the young. Their view of the Spaceship Earth with its people living closely together will in time replace the distortions of Mercator's flat projection

showing every country highly colored within its political frontiers — just as Galileo's view of the universe replaced the flat concept of the Ptolemaic astronomers.

### *Popular Pressures*

Nationally, the demand will express itself in more subtle ways. The pressure for open government which reveals the choices before they are made will intensify. Decisions affecting the use of science and technology, whether by governments, corporations or universities, will become increasingly the subject of critical scrutiny, as has been shown most vividly by the recent economic and environmental debates and decisions on the development of the supersonic transport. People may still argue as to whether the decision was right or wrong, but no one can doubt that it was taken openly and that the decisive pressure came from below in sufficient strength to overturn the wishes of an Administration and the aerospace industry, both of which wanted to go ahead.

Similarly, the environmental pressures that have built up over recent years can be seen as having a political significance greater even than the actual cause which the environmentalists espoused. They can be seen as a direct political demand under the classification of technology assessment aimed at securing a proper consideration of the consequences of all decisions before they are reached, so that the side effects can be taken into account at the time of the basic decision. This is a move to better and more democratic decisionmaking, and if it can be made a permanent feature of political life, it will be far more important even than the improvement of the environment. It may, in fact, serve to check the wildest environmentalists who are now pressing for unrealistic policies which could have unexpected industrial and human side effects.

But the pressure for democratization wil not stop there. It is bound to extend to the democratization of industrial power, through workers' control, educational power and the power of the mass media which, by their control of information output, can play a decisive part in shaping society.

We are presently so conscious of the centralizing forces that derive from technological change and of the huge new and powerful bureaucracies that they have created that many people tend to be despondent, to believe that ordinary human influences are quite powerless and the cause of democracy is irretrievably lost as man surrenders to the new power centers. The emergence of countervailing power from the grass roots is less easy to recognize. It is dispersed so widely, its exercise is so uncertain, and the time scale of its successes is so long that many people do not believe it really exists. At the moment it may be only a potential power, but its potentiality is far greater than most people realize. We have not yet learned to organize ourselves to use the power that has fallen into our hands because we are not fully aware of it and because it requires us to think about our system of government in quite a different way.

The study of civics or political institutions as most of us learned about them at school, or through the mass media, always focuses upon the formal structure of the nation state. We are told how accountability has been secured by freedom of speech and the vote. But even this interpretation stresses what our leaders do and say. Policy and changes of policy are presented to us as coming from the top.

### *Change from Below*

But is that really how our political system works? I greatly doubt it. There is an interpretation of political change under which one can argue that it is change from below that has been and is really significant and can, over a period, be decisive. Certainly, the demand for the vote was a demand that came from the grass roots and was reluctantly conceded by the political leaders of the time. The demand for human rights or racial equality has never been particularly acceptable to those in authority in societies which denied these rights. The groundswell demand for free trade unions or socialized education or socialized medicine in a welfare state was not thought up in the corridors of power. They bubbled up in the community, lapping around the foundations of the establishment until they acquired sufficient momentum to swamp the opposition in Congress or Parliament. By this means, too, the environmentalists captured the White House and Number 10 Downing Street, making it clear that they would no longer tolerate the barbarities of technology. The new movement for women's rights has also gathered force outside the system and is already making progress within it against the entrenchment of male privilege.

It is arguable from this that the historic function of the politician is to capitulate, and that the good politician capitulates only to forces that he has helped to create by education and argument and by his encouragement of those who are trying to extend the area of human responsibility.

Indeed, the task of statesmanship today requires leaders to be more than bureaucratic administrators of vast governmental machines. For anyone who looks around him and, even more, anyone who looks ahead should see one fact staring him in the face. The amount of power that the technological revolution has created far exceeds the capability of even the most inspired, dedicated or brilliant leaders to control unaided.

In June 1940, when the seemingly unconquerable German Army stood poised on the French Coast ready to attack Britain, Winston Churchill pledged himself to carry on the struggle "until, in God's good time, the new world with all its power and might steps forth to the rescue and liberation of the old." That is exactly the position confronting the statesman of today as he observes the massive and menacing power of technology which encompasses us. He must carry on the struggle until, in God's good time, the people with all their power and might step forth to the rescue and liberation of mankind.

Only a massive dispersal of power conveying responsibility beyond and within the nation state to those upon whose wise exercise of it our survival depends can possibly redress the balance in favor of the people in their battle to gain control of the machine. To pretend otherwise would be an illusion — an illusion we can ill afford to nourish.

# II. Technology and Society — The Real Issues

*"We who have been part of the technological revolution . . . know, of course, that in truth no one has been in charge of technology. Certainly no federal policy on technology has ever been written down. Instead, technological change has occurred at random, depending only on the appearance of a technological entrepreneur and a bit of luck. On balance, the results have been far from all bad. But the bad parts are now becoming unbearable, and it is the responsibility of those who would be leaders to understand the concerns of those whom we would bid follow." Myron Tribus is senior vice president of research and engineering for Xerox Corporation.*

*MYRON TRIBUS*

The attacks on technology on the one side and the spirited defenses of technology on the other may serve to divert our attention from what seems to me to be the real issue — namely, how are we to assure ourselves that technological forces are harnessed for the common good and that mere technological change is not pawned off on us as "technological progress"?

Those who attempt to argue against technological advance because they wish to improve mankind's lot are in a self-contradictory position, arguing against their own objectives. Improved technology is what it takes to rescue the environment, conserve our resources, rebuild our cities and provide better health for our people.

I can imagine no more dramatic example of what a difference technology makes than the devastation in Pakistan in which approximately 300,000 lives were lost when a hurricane struck an island there. These people had no modern communications, no transport, no steel and concrete buildings, no earth-moving technology. The few who survived had to rely on air-lifted provisions from the technologically advanced countries. When the next power failure occurs, let those who inveigh against technology ponder what their lives would be like if the power were never to resume.

But those who argue for technological progress as an end in itself reckon without sufficient concern for what constitutes "progress" and with insufficient attention to the underlying grievances of those whose lives are affected, and who feel threatened, by the continuing advances of technology. The sad historical fact is that those who have had a major voice in determining how technology is to be used in our society have not always been sensitive to the needs of those whose lives were surely going to be affected. The examples are legion. We have only to look at the loss of San Francisco's Ferry Building to an ill-conceived freeway or hear the deafening clatter of our transportation systems to realize that whoever was responsible did not have much concern for the amenities of life. The headings for stories in just one issue of the "New York Times" tell us why there is a general concern for what technological change will do next: "Lyons, Kansas, To Sit Atop the AEC's Radioactive Waste Dump," "Senator Decries Computer's Potential Role as Big Brother," "Former Federal Automotive Safety Chief Says U.S. Cars' Fragility Picks Consumer's Pockets."

The issue is not whether there is to be more or less technology; the burgeoning birth rate, urbanization and total dependence on energy grids for survival have settled that question. The issue is over who is to be in control. What is now needed is a new social invention, one which parallels an earlier social invention which aimed at securing "the consent of the governed." We need now to learn proper ways to secure the consent of those affected. As with obtaining the consent of the governed, the success of a method to secure the consent of those affected by technology will certainly depend on education.

### *Ever-Increasing Role*

Until quite recently, the development of a new technology depended mainly upon market forces, that is, upon the private sector. But World War II introduced important changes, and for the last 25 years we have seen the federal government play an ever-increasing role. There has been federal support of aviation, electronics and materials by the Department of Defense, extensive funding of atomic energy by the AEC, subsidized shipbuilding by the Maritime Commission, and now plans to subsidize rail transportation by the Department of Transportation, to name but a few.

The philosophies of Congress and the Executive branches have been to avoid having the federal government itself introduce technologies. Rather, it has consistently been the federal intent to encourage the private sector. This aspect is often overlooked by those who presume to speak for the private sector in opposition to federal programs aimed at advancing civil technologies. For many years there have been unmet needs for better technologies in such areas as fire fighting, housing construction, machine tools and textiles, yet all attempts at improvement have met heavy opposition from various lobbies. On the other hand, increasingly over the last 25 years, we have seen an ill-defined but extremely effective partnership between the federal government and private industry in selected areas of technology

which has brought forth the most remarkable series of advances the world has ever seen in computers, aircraft, materials and instrumentation.

The system was extremely simple. The federal government spent about $15 billion in R&D, creating a climate which attracted some of our brightest minds into science or engineering. A generous flow of dollars to colleges and universities assured student support. Federal funds for development contracts in industry took the risk out of many ventures and created an overall climate that was right for "spin-off." It really did not matter whether the "spin-offs" were direct or not — advances in radar had to mean advances in television. It was not that the designs were taken out of defense and into corporations such as RCA. Rather it was that contracts to extend the state of the art in telecommunications provided new ideas, new concepts and new materials which could be adapted to new purposes by alert industries.

### *Who Is in Charge?*

But this collaboration seems now to be coming to an end for several reasons, all traceable to a common concern over who is in charge of technology. We who have been part of the technological revolution of the last 25 years know, of course, that in truth no one has been in charge of technology. Certainly no federal policy on technology has ever been written down. Instead, technological change has occurred at random, depending only on the appearance of a technological entrepreneur and a bit of luck. On balance, the results have been far from all bad. But the bad parts are now becoming unbearable, and it is the responsibility of those who would be leaders to understand the concerns of those whom we would bid follow.

It does not really matter that many who oppose technology do so blindly and irrationally. Students purchase a $3,000 automobile, destroy it, and bury it to show their displeasure at the motor car. What good does it do to remind them that they went to and from the "burial" in their own autos, polluting all the way? What are we to say to the committee which meets in an air-conditioned hotel to demand that the electric utilities stop building new power plants? If they would meet in tents by candlelight, they would at least be credible.

Living with the political and social realities makes it easy to recall why Socrates eschewed political connections because they compromised his ability to speak the truth. It makes it easier to understand why it was that the Clean Air Act for 1970 was passed by the Senate, 79-0, even though it clearly stated that standards would be set without regard for whether it was technologically feasible to meet them. And that same Senate shelved a proposed penalty tax on leaded gasoline even though the evidence is clear that leaded gas of equivalent octant rating is cheaper to manufacture than unleaded gas. This means that leaded fuel can be sold more cheaply than unleaded for the same automotive performance and, therefore, nonpolluters pay more.

Finally, those of us who would urge a more balanced view of technology in our society are scarcely helped by the hucksters among us whose shrill cries in favor of complete freedom are a constant source of embarrassment. Today, of course, we are beginning — just beginning — to see a more responsible line from private industry. But ill-begotten images die hard and today's automobile manufacturers must yet live down their earlier reputations for cavalier responses to question of safety and pollution. Now our soapmakers must regain credibility with the housewife over enzymes and phosphates.

### *SST Program*

What we are witnessing is a crisis in confidence — a loss of trust in those who control the advance of technology. And until we recognize that this is the real issue, we shall not really solve any of the problems we face. All our logic will be lost on those who do not trust us.

Consider the case of the SST. The supersonic transport program was begun in 1962 when the Department of Transportation gave contracts to General Electric and Boeing Aircraft for the development of a commercially viable supersonic airplane. It was known from the outset that there might be difficulties from noise, the supersonic boom and pollution. But those who managed the project in Washington tried to keep these matters as quiet as possible, hoping that they would be solved before the airplane flew. But by 1967, it was obvious that the boom problem would not go away and the noise problem was not yet solved. The designers did not think the public would really care. They thought that the people would or should accept these nuisances. When William Magruder took charge of the SST program in 1969, he did what he could to rectify this lack of socially responsible leadership, but he was too late. What did him and his program in was not the technical merits of the case. I believe that the pollution issue was not real, that the effect of the boom over unpopulated areas was grossly exaggerated, and that the noise problem at take-off could have been overcome at some added cost in fuel economy. The question before the Senate was whether to build two prototypes, and the answer, in the last analysis, turned on whether the opponents of the SST believed that Magruder and his colleagues would be willing to stop the program if it turned out the prototypes did not meet the noise and pollution limitations laid upon it. Charles Lindbergh testified by letter that he opposed the program because he had concluded that history showed that technologies like the SST, once let loose on the world, had a life of their own and would crowd out Nature and Man.

All the other issues raised were not the main issue. The questions about ecology and noise could have been answered — without debate — by measurement. But because the leaders of the SST were burdened with the sins of all past technologists, they could not bridge a credibility gap and they failed to win support. The sad fact is that Congress and many of the people did not trust them to be responsible to society.

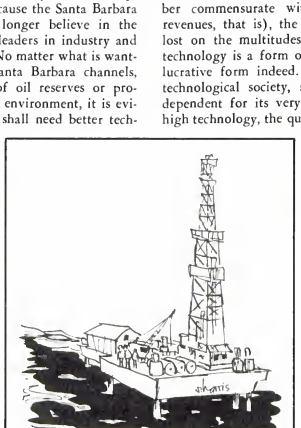
An inconsistency between a man's actions and his stated objectives is usually a dead giveaway that his real motives are not the ones he said

they were. After the supersonic transport funding had been denied by the Senate, it was most interesting to hear a number of Senators who had fought the program on ecological grounds speaking on television and stating that they hoped that private funding would be found to continue the project. Listening to the debate and discussion prior to the project, it appeared that these opponents wished to defeat the SST program because they feared its ecological consequences. That this is not a genuine fear is revealed by their encouragement of the private sector to continue its development.

Beyond this, however, there is the issue of finding out the truth about supersonic aircraft and ecology. It is my opinion that both sides lost. The United States, having backed out of the SST race, has no opportunity to influence the design of foreign aircraft and, in particular, no influence over their possible ecological hazard. Although the ecological hazard has, in my opinion, been grossly overrated, as long as there is any doubt, it is important to pursue the requested research studies to settle the issue. Yet I have heard no discussion whatsoever from Congress regarding the funding of these studies, and it is probable that now Congress will turn its attention elsewhere and the bureaucracy will assign a very low priority to these studies. Europeans plan to operate SSTs to our shores. The question of whether or not a fleet of SSTs could cause damage to our environment was and remains a legitimate question. I believe that the answer will be found to be negative; but I also believe that we ought not to let the matter stand at that point. We should press on and assure ourselves, before any damage can occur, that the impact of these aircraft will not be harmful. Such research takes time, costs money and requires the allocation of resources.

The example of the SST was one in which the federal government played the central role as technological entrepreneur. Distrust of the decisionmakers in technology is most easily focused when it is clear who they are, as it was in the case of the federal SST program. A case in which the leadership is more diffuse and, therefore, one in which the opposition has trouble becoming focused is that of oil spillage in the oceans and on the shores. The Santa Barbara channel has rich oil deposits under the waters. There are numerous oil wells already there, and if these were to be abandoned, there would still remain the chance that, due to an earthquake, one or more of them would rupture and leak. The oil derricks off shore are an eyesore and offensive to the aesthetic sensibilities of those who live along the Santa Barbara coastline. The rational way to deal with the problem would be to design totally submerged platforms equipped with suitable safety systems to capture immediately any leakages. If such systems proved to be uneconomic at this time, the wells would have to be abandoned with standby provisions for responding to emergencies. Since the land is owned by the federal government, which takes considerable revenue from the leases, it would make sense for the federal government to enter into an R&D program with the oil companies to develop the needed systems. Such a program is unlikely to attract support today because the Santa Barbara residents no longer believe in the word of our leaders in industry and technology. No matter what is wanted for the Santa Barbara channels, exploitation of oil reserves or protection of the environment, it is evident that we shall need better technology for underwater operations in the oceans and near the shore. We should be advancing this technology, not retreating from it. But because of the attacks upon technology and the distrust of technical leadership, these programs flounder.

In the computer business, it is the custom to speak of hardware and software. The hardware is represented by the machines themselves and the software is the set of programs that tell the machines what to do. The impact of technology on society may be viewed as an interaction caused by both hardware and software. The barriers to the effective use of technology on society's problems are almost all software problems and these software problems ultimately revolve around the struggle for control. Unions in the construction industry fight prefabrication because they are not sure they will be able to retain job security. When the most modern advances in telecommunications are used to guarantee that the smallest number of persons will be informed regarding the progress of the "fight of the century" between Joe Frazier and Muhammed Ali (the smallest number commensurate with maximum revenues, that is), the lesson is not lost on the multitudes. Control of technology is a form of power — a lucrative form indeed. In a highly technological society, such as ours, dependent for its very existence on high technology, the question of who



**"Look at the bright side — employment for thousands trying to clean it up."**

controls technology assumes greater and greater importance.

The quest for better control of technology has reached Congress, although it is hard to say that Congress has made much headway with it. There have been a few bills introduced calling for "technology assessment," a phrase much in vogue in 1968 and 1969. The National Academies of Science and of Engineering have each issued reports in favor of technology assessment — the prediction of the probable social impacts of a new technology. But it is a matter of record that despite the discussions for two years, we have yet to see one good example of a genuine technological assessment. After the fact, of course, the social impacts of technology are easy enough to assess. The mechanization of agriculture has lead to greater farm productivity and, therefore, to the migration to the cities. This effect was predictable, but I doubt that improved farming could have been held back and I seriously doubt that the cities would have made themselves ready for the influx. Until recently no mayor or governor would have conceded that a population boom was not what his city or state needed most. While serving as the President's Science Advisor, Lee DuBridge once wryly referred to technology assessment as "technology harassment." In my own testimony before the former Daddario Committee of the House of Representatives, I urged that funds be expended soon in the making of a few technology assessments so that we could find out whether they were feasible to do, what they might cost in money and manpower, and what we might reasonably expect of them. Daddario is now no longer in the House and, as yet, no one else has come forward to speak for science and technology in Congress. I believe the discussion of technology assessment needs to be broadened to consider the subject of control of technology: Is it possible? Is it desirable? If control is impossible, perhaps we are better off trying to do technological forecasting — a less ambitious undertaking, but one with greater probability of success.

The uneasiness about technology and our seeming inability to come to grips with it are characteristic of the mood of drift which seems to have overtaken our country. The Japanese, for example, know full well why they must have the best in technology. A population of 102 million, perched on an area less than that of the state of Montana, with less than half the land area suitable for cultivation, with limited natural resources must have advanced technology or perish. This recognized need for technology in Japan creates a far different climate for technology there as compared to here.

In the United States, on the other hand, there are few deep commitments to any public purpose. There is much talk — but most of the talk seems more designed for political advantage than concrete action. The attempt to draft a set of National Goals in 1970 expired in a quiet and unmourned death. The report of the Committee on National Goals, dated July 4, 1970, produced no sense of urgency, dedication, or commitment in anyone, including the Committee itself. The quest seems now to be for a return to normalcy: to a more satisfactory economy, to enough relief from problems of race, poverty, or the environment to mollify or at least render less potent those who press for reform.

In testimony regarding the need for a policy on technology, I tried over and over again to make the point that such a policy is not an end in itself. Technology is not an end in itself. Technology is a tool to be used for a purpose. When we have established policies on education, on health, on our cities, on the environment, on our balance of trade, on employment, then we shall know to what purposes we should put technology. And when we understand and are committed to these purposes, our youth will again take an interest in technology.

This presentation has been far too critical thus far to suit my taste. Let me now end it on a happier note, by describing an important advance in technology which, unlike many other aspects of technology, is being directed in a responsible style. I refer now to the advances being made in our ability to modify the weather. As chairman of the Interagency Committee on the Atmospheric Sciences for about 18 months, I had a chance to work with the best people in meteorology and atmospheric physics in the nation. These people are on the verge of great accomplishments in enhancing our ability to do such things as augment snow pack in mountains, combat hail, reduce the force of hurricanes, divert snowfall from cities to mountains and increase tropical rainfall. What I find impressive about their style is the careful way they have gone about keeping the people involved — those whose lives would be affected — aware of what was going on. In Florida, representatives of the tomato growers helped watch the radar screens and had a voice in deciding when and where experiments might be done. Residents of Western states were queried as to what they knew about these procedures. Ski resort operators of New York were kept posted and invited to keep an eye on the research. I am proud to observe that in no instance has the federal government repeated the terrible mistake of the Armed Services, which, in the late 1940s, classified some parts of Project Cirrus just so no private citizen would have a basis on which to bring suit in case those abortive attempts at weather modification really succeeded.

And now one of the greatest advances of all may well be just ahead of us — the ability to reduce the damage from a hurricane. It is the researchers and their leaders, themselves, who have raised the question of when and where this technology is to be displayed, who have asked for guidance on the legal, social and ethical questions that this new technology poses.

This is a new style, one which I can heartily endorse. Even without special leadership and without formal policies, we often do some things right. I suspect that there are more technologies being carried forward responsibly; it is just that responsible progress is not newsworthy. But little by little we do gain on our problems. It is, I suggest, reasonable to hope that as more people in technology become more sensitive to these issues, and show their sensitivity by their style, and as technology is more observably pressed into the service of man, the trust will return.

# III. THE ENGINEER IN THE ESTABLISHMENT

*". . . the maximum progress possible on the basis of our present knowledge and manpower will fall far short of meeting our needs. Problems faced by this country are so difficult that we shall be disappointed no matter how much effort we expend. This is true although the mind of man augmented by machines is capable of far more than has yet been accomplished, given adequate financial and moral encouragement." Daniel C. Drucker is dean of engineering, University of Illinois at Urbana.*

## *DANIEL C. DRUCKER*

The attackers of science and engineering really have far too much faith in the ability of engineers to solve problems. They have so high an opinion of our technical ability that they are convinced our errors of omission as well as commission are purposeful. In their childlike faith they believe that all our engineering-related societal problems — housing, transportation, pollution — would be solved, or never would have been created, were we not venal or amoral or lazy. After all, we did put a man on the moon according to plan. I shall return to this most important error of perception after exploring a while longer the identification of engineers and technology with evil rather than good.

Engineers view themselves, on the whole, as servants of society. Those who view society or the Establishment as inherently evil then have cause for transferring the label of evil to engineers. When society, as represented by those who govern the setting of priorities, votes for military weapons, weapons are developed. When laws permit pollution by industry and tax incentives attract polluting industries, industrial plants which pollute will be built by engineers.

A split personality sometimes develops with an engineer or scientist serving the demands of society during his workday and protesting the decisions of society in his leisure hours. Engineers may be criticized for this subservience to the will of the majority, but their behavior really is more appropriate than the technocracy concept of engineers governing society. If we believe in democracy, we must behave in accord with that belief. Anarchy is not a viable alternative in the interdependent world of today. It is necessary to work within the system to change the system.

Working as directed by a clear and informed majority opinion has much to commend it. Engineers do have the obligation and now are seizing the opportunity to present their assessments of the present and future to the policymakers. They are engaged actively in the debate on proposed solutions to societal problems. Yet once the group decision is made, engineers, by tradition and inclination as a class, will help to implement it.

Engineering has served society extremely well by the standards society has set for itself. The basic criticism is that engineering did not lead society. Engineers did not lead in the political movement for automobile safety, or for more stringent laws against air pollution. This is a serious charge against a professional group, and its partial validity is now acknowledged by the engineering societies. However, it should not be confused with the charge that engineers caused vehicles to be unsafe, or caused pollution, or failed in the role society as a whole had assigned to the profession. It is the ground rules of society which have changed in the last 25 years and have undergone especially rapid change in the last decade. Translated to its simplest and possibly unacceptable extreme form, the engineer (really the political or economic policymaker) no longer is to give the public what it thinks and says it wants. This historic turning point may be here or just around the corner. It will be a turning for the better only when we agree that we know enough about how to solve our problems.

It is too much to expect the average person acting on his own to give up his favorite toy and prestige symbol which pollutes the atmosphere and injures about two million people a year. It is too much to expect the average engineer or the average businessman to insist upon standards of safety and excellence so far above the norm that economic failure would result from such unilateral action. Governmental action and controls, through tax incentives and penalties in particular, is essential. It is not that appeals to professionalism or to innate goodness and concern for the future fall on deaf ears. They simply are drowned out by far greater clamor for less expensive goods and services, for highways convenient for the majority despite the damage they do to central city areas, for airports located near to downtown rather than far out in the pleasant countryside, for schools at all levels which cost as little as possible rather than those

which educate as well as possible. The typical response today to clearly demonstrable long-range needs of society is a great deal of talk and very little money. We do not vote additional taxes, we try to reduce taxes and talk about reordering our priorities. The typical speaker we invite to chastise us at engineering meetings usually urges a reordering of priorities. He proposes that the defense budget, the space budget, often the foreign aid budget, be cut and the money saved be spent on the urban and the rural poor. We nod our heads. We too agree that priorities must be reordered.

### *Evading Real Issue*

I suggest that this emphasis evades the real issue. It casts the argument in the wrong terms. If we believe in helping the poor, we should say so without qualification. We must be willing to sacrifice to do so — not simply to reorder priorities and so not raise taxes and not cause us the slightest degree of pain. It disturbes me to hear it implied that not only can we help the poor but we can save money ourselves by the "reordering of priorities." No matter what we think of the Defense Department, it remains an economic fact that cutting its budget and reducing our taxes will produce additional unemployment, especially among minority groups.

The only way to help the poor join the mainstream of American life is to provide goods and services and, most of all, jobs. Our capacity to produce competitively in world markets must increase enormously. Competitively is an essential qualifier if we are to maintain employment at home. Also, the productive capacity of the entire world must make tremendous jumps if the average person in the world today is to live half as well as the poor in this country. Our survival depends upon this rather conventional application of technology. We must go beyond this immediate need and at the same time reduce pollution and increase the quality of life. This is an awesome task. Tax reduction, a choking off of technology, a reduction in basic and applied research, a throttling of our educational institutions — each individually will lead us to disaster. So too shall we face disaster if a sizeable fraction of our brightest youth persist in a pseudo-commitment which means withdrawal in a smokescreen of talk.

### *Basic Misconception*

This then brings me back to the basic misconception of the critics and many of the defenders of engineers and technology. We do know the problems which must be solved if the quality of life is not to become intolerable for all of us, not just the poor. Despite the moon landing, despite the fantastic accomplishments of modern engineering, we do not know how to solve most of the problems we face even in their purest of technical forms. Every time I hear the statement that the important problems are social and political, not technological, I shudder. Quite apart from social acceptability, an engineering solution must be an economically permissible one at least. Certainly we can clean up the air, or the water, or the cities. We can provide adequate transportation. We can do just about any one of a number of good things, but we do not know nearly enough to do any sizeable fraction of them within our available resources. Even worse, in far too many instances we are so ignorant of the consequences of our acts in an ecological or human sense that we are totally unable to weigh the pros and cons of a change from a presently undesirable practice.

My view of engineering through the ages is one of profound admiration for the accomplishments of ordinary men and men of genius, men who have learned through error as well as success. As the mathematical and scientific base of engineering has improved and increased, the successes of the past have become codified and available to future generations while the failures of the past can be avoided. More and more can be computed and predicted in advance through theory and experiment. However, engineers are always called upon to tackle problems beyond the frontier of knowledge. Some failure is inevitable, even in the traditional fields. How naive to expect precision of prediction, an accurate assessment of costs and feasibility, or true success when such a project starts. The best one can hope for is success without regard to cost when there is basic understanding and when clearly foreseen advances in the state of the art are needed without true breakthroughs. The moon landing was a superb engineering achievement but it was within this classification. The solution to our energy crisis in the complete social, political, economic and technical sense is not. Health care delivery systems, transportation systems, urban and rural planning, housing, pollution — all of our major problems and an infinite host of minor ones are collectively beyond our capabilities at present.

### *Beyond Reality*

We have been blinded ourselves and been deluded by our critics into an acceptance of an engineering capability orders of magnitude beyond reality. Except within the impossible constraint of a fixed technology, our problems are not basically sociological or political. Most will never be solved without major technological advances. The collective or individual reactions of people are terribly important and must be satisfied for a solution to be a solution. Yet, were we to know all about people and their behavior, present-day technology and a complete reordering of our priorities would fail miserably to begin to meet our expectations for the world of tomorrow. Of course, we know even less about people than about science and almost nothing about how to bring the social sciences together with the sciences and engineering.

The main point I should like to make is that the maximum progress possible on the basis of our present knowledge and manpower will fall far short of meeting our needs. Problems faced by this country are so difficult that we shall be disappointed no matter how much effort we expend. This is true although the mind of man augmented by machines is capable of far more than has yet been accomplished, given adequate financial and moral encouragement.

We now live in a time of physical and social crisis, but our response cannot be one of panic with our full attention devoted to the immediate issues of the day. The argument that

we must devote all of our energies to the problems which confront us now, or we shall not survive to meet the future, is self-defeating.

We always shall live in times of crises, we and our children after us, and their children. Surely we must overcome the worst of our immediate stumbling blocks. However, realism, not wishful thinking, should govern our allocation of that scarcest resource of all — highly educated people.

Partial success in tackling today's problems is all we can hope for because we know almost nothing about how to eliminate most of our present difficulties. The realistic approach is to employ a large fraction of our ablest people not in manning the ramparts, but in a systematic study to stave off complete disaster by the year 2000.

### *Make No Choices*

We must reaffirm our tradition of educating everyone to the highest level consistent with his or her ability and aspiration. We must not make a choice between better elementary education, or better high school education, or better college education, or graduate or postdoctoral education.

To the statement that we cannot afford to do all of these well, the answer must be that we cannot afford not to. On the average, the higher the level of education reached, the greater the contribution any individual can make, and the better off we all shall be.

We read today that there is a surplus of teachers at most levels. What nonsense when our educational system is so inadequate for the rural and the urban poor and provides so meager a challenge for the brightest of our students at all levels that they grow up believing themselves more knowledgeable and mature than any of their teachers.

We hear today about the surplus of scientists and engineers. Distinguished leaders seriously suggest that we should discourage young men and women from graduate study, and if they insist on graduate study we should discourage them from research.

We do indeed seem bent upon our own destruction, whether we view the world as isolationists concerned primarily with the survival of this country, or recognize the oneness of our tiny sphere.

Every now and then the American educational tradition is reaffirmed. Michael Bakalis, Superintendent of Public Instruction of the State of Illinois, stated it clearly: "But if one child in Illinois is denied the opportunity to reach the level of his educational potential, then all of us will be the losers." This simple truth of long-range societal gain holds at all levels of education from the elementary grades through to postdoctoral training. As the level of education rises so does the cost per year, but so also does the eventual return to society.

### *Higher Education*

Accurate prediction of the numbers of students at each level of education is difficult. It may be of some help to visualize the entering group as consisting of about 100,000 first-grade elementary school classes in session across the country with almost 40 pupils in each. On average, certainly two pupils in each class have the intellectual potential to go on to doctoral work. The 200,000 per year is about five per cent of the total. Suppose one-fourth of these potential doctoral candidates has the desire as well as the ability. Public policy should do more than permit so small a fraction of the population to continue to the highest level; public policy should actively encourage the development of this rare natural resource. Unlike coal or oil or metallic ores, this resource if untapped is forever lost.

We recognize the need for many years of education and training for medical doctors who provide for our physiological and mental health. Should not a substantial fraction of those specialists responsible for our industrial, nutritional and social "health" have an education as demanding as a medical specialist receives?

Highly educated people are required in a wide variety of fields. Engineering, which represents a small but significant fraction of the total, is singled out here for obvious personal reasons. Also, the numbers are quite well established and engineering ranks high in the scale of disciplines upon which our industrial and societal position and progress depends. That 20 per cent of all doctorates will be in engineering is an Office of Education projection for 1980; the 10,000 per year by 1985 is based on one-fifth of the bachelors degree recipients and is conservative in comparison with experience in physics and with projections of over two decades of very rapid growth which is now throttled down by financial stringency.

The numbers and the cost of higher education appear to be staggering but the cost of not providing the opportunity is even more overwhelming. In fact, we have already made the major commitment or are in process of doing so.

At present 750,000 or so bachelors degrees are awarded by our colleges and universities each year; by 1985 this figure is likely to exceed one million. By 1985, 50,000 doctoral degrees is a reasonable goal — almost twice the present output — and 10,000 doctoral degrees in engineering seems appropriate. By 1980, 8,000 doctoral degrees in engineering can be achieved — about twice the present number.

The cost of increasing doctoral output is substantial.

The Advisory Committee for Engineering of the National Science Foundation has estimated that $500 million more per year will be needed for engineering alone, some $2 to $3 billion per year for all fields. Enormous as this figure seems, it must be recognized that the total is less than 0.3 per cent of the gross national product, less than $15 per person per year. It would be more than repayed to the American public if the result were an increase in family income of only $100 per year. A more extreme view, but one which carries considerable conviction, is that this cost is equal to less than five per cent of the defense budget and so is a small price to pay for insurance to avoid the civil catastrophe which awaits us if we do not solve our problems in a reasonably satisfactory manner. The modest approach is that benefit would far exceed cost if there is any validity to the argument that the pressing problems of society must be

met in an economically viable manner within the context of a technological civilization of almost incredible complexity.

To me, one of the greatest challenges of the next decade or two within the universities is to attempt to create a discipline or a set of disciplines lying between engineering and the social sciences. Such a true interdisciplinary effort can be meaningful and successful only when first-rate engineers and first-rate social scientists interact as equals in common research and teaching tasks. Even if this grand design is beyond our capabilities, the understanding and the methodologies developed in a true team effort provide the only hope I can see of arriving at reasonably optimum policy decisions. As time goes on, the luxury of major mistakes in direction will involve monetary and social costs beyond our resources. I view the engineer, operating at a very high level, as the driving force in a partnership of intellectual equals because he is oriented to action as well as study.

Perhaps more significant still, the engineering MS and PhD group will be by far the major source of supply of suitably educated people. All disciplines will have to contribute if valid answers are to be obtained. However, numerically and philosophically, both by nature and education, the engineering component will dominate. The implications of this for engineering education and the selection and guidance of students must be examined carefully.

As I put it to the entering freshmen class in the College of Engineering at Urbana and to anyone else who will listen:

> If a young man or woman wishes to improve the human condition, to decrease the pollution of our physical and social environment, there is no better base from which to start than an engineering education. Social and political awareness are essential but action — effective action — requires disciplined knowledge. Most of our problems are far from pure engineering or technological problems. Their solution, however, will require a very strong, probably a dominant, engineering input. Certainly this is true for the developing countries of the world, but it is true also for us here in the United States.

# IV.

ALAN G. MENCHER

*"Responsible scientists fear that unless erroneous convictions are dispelled there is a real danger that festering anti-scientism could eventually destroy science. In so doing, it would destroy a part of society itself because science is more part of the composite activity of a society than an isolated pursuit of an elite group. . . . It is a social responsibility of the scientist and engineer to help correct the vast and dangerous misconceptions about themselves, what they do and how they do it."* *Physicist Alan Mencher is science attache with the U.S. Embassy in London.*

# On the Social Deployment of Science

Science is neutral. As has been said, equations do not explode and technology can be used for good or for evil. They are both a part of the world's culture. Science-based technology is one of the great creative forms of our time.

Conventionally, science is defined as a generator of new knowledge, while technology is its application. At the same time, the history of science shows that the attack on practical problems points up new theoretical problems. Technology also feeds science by providing the tools and instruments needed to develop new knowledge, while an increase in our understanding of how nature operates (the subject of science) inevitably leads to an ability to manipulate it for our own purposes (the subject of technology). This complex interplay which has been one of the most fruitful factors in the growth of science, and which is the very life blood of technology, makes it axiomatic that the pipelines of scientific knowledge must be kept full.

Basic research is a natural resource, just as agriculture and mineral deposits are, and as important to the public concern as military security, education and the management of the economy. It is a very real force in international politics, a fact learned by the United States with the accrual of power after World War II as a consequence of the generation and application of new knowledge.

Of course the role of science in power politics and military affairs is one of the major causes of the attacks to which it is subject. But the ultimate importance of fundamental research, twinned with technology, to every major national social goal, is incontestable. If for no other reason — and there are many others — it is necessary to develop sufficient knowledge now lacking to permit the development of sensible action programs to attack environmental problems.

The field of ecology has hardly been born. There is very incomplete understanding of the processes taking place in the few square yards of earth forming the life system called a terrarium, to say nothing of larger systems that form the real world. In a recent film on British television, American investigators were shown observing a young goat on the pasture land where he was grazing. They were equipped with walkie-talkies, and the commentary went something like this: "Two mouthfuls of grazing grass. Three of blue grass. Two of yellow-cupped meadow flowers," and so on.

But let us not be deluded into thinking that science can be separ-

ated into socially acceptable and socially unacceptable parts. The former Soviet Foreign Minister, Maxim Litvinoff, used to say "Peace is indivisible." So is science. Advances in one area are often necessary for progress in another. Modern biology and genetics would not exist without the invasion of the chemists studying the structure of proteins and other complex biological molecules.

Responsible scientists fear that unless erroneous convictions are dispelled there is a real danger that festering anti-scientism could eventually destroy science. In so doing it would destroy a part of society itself because science is more part of the composite activity of a society than an isolated pursuit of an elite group. Because we focus on it, we risk the error of looking on it as a relatively closed activity whose internal operations are of no interest, rather than as one which interacts closely with the other activities making up the nation. It is a social responsibility of the scientist and engineer to help correct the vast and dangerous misconceptions about themselves, what they do and how they do it.

The difficulty in correcting these misconceptions is, in my view, not merely one of a communications gap but also one of the mutual education of groups that are heavily insulated from one another by virtue of differing mental modes.

Consider the fundamental differences between the science-oriented student and his humanities-oriented colleagues. Aspiring scientists and engineers share high professional motivation. To them, science and technology fulfill an essential role in contemporary society. They find it a satisfactory intellectual challenge. They have a capacity for thinking in abstract terms, a talent in visualizing spatial relations, skill in mathematical manipulation and a commitment to the orderly development of a line of thought from hypothesis to conclusion. They are often slow readers, poor writers, compulsive consumers of detail (a minus sign in the wrong place can be a catastrophe) and generally better at analysis than synthesis.

Those attracted to the humanities have a greater tendency to be verbally oriented. They develop more easily a facility for rapid absorption of large masses of printed material from which they learn to abstract key points and issues rapidly. Their oral expression and vocabulary are generally richer than that of their scientific counterparts, and their expression and style in the written language are generally superior. They more readily develop the technique of synthesizing trends from individual acts and of generalizing from a series of particulars. Generally, they are better speakers.

These two sets of talents are not at all mutually exclusive, but in general, people seem to incline toward one mental mode or another, and the existing educational and cultural structures push them further apart.

As a result, scientific illiteracy (in my view, a dominant barrier to the resolution of the dilemmas of de-

ploying science for social objectives) can crop up in high places. A story is told by Robert Sproull of a man who subsequently became president of one of the dozen most prestigious American universities. This man seriously believed that if a coin is tossed 10 times and comes up heads each time, the probability is greater than one-half that it would come up tails on the next toss "in order to make the law of averages come out right."

Why should this be important? Because a world largely populated by scientific illiterates is called upon to voice its opinions, preferences and even judgment on matters of social choice having high technological content. Their exposure to the ABCs of the world of science might avoid the propagation of a deplorable mythology.

Unfortunately this exposure is blocked by a very real communications problem between scientists and the public. I refer to this problem as Beer's paradox after Stafford Beer, the distinguished British cybernetician who claims that "the media of communication — of all things — stands between the public and the real insights of science."

By now we are bored with the laundry list of new knowledge: Scientific information is doubling every decade; a typical university library doubles in 30 years; the computational work of a team of 20 people during World War II, working for a year with the then generation of IBM machines, can now be done in one afternoon by one person while 100 other people are using the same computer.

This state of affairs commends education of the public through the media, particularly in the area where science and technology have such a devastating impact on social action. Many scientists recognize the importance of television and want to use it to communicate with the public. But they suffer badly in the competition for audience which is based on the producer's evaluation of commercial return.

Although Beer's remarks are directed toward British television, they are more generally applicable. He argues that the slant projected by science-oriented programs is effectively that of the producer who makes the program and can edit and assemble the material in such a way as to say whatever he likes. Very often the scientists are not even included. This is a case of McLuhan in reverse, where the medium masks the message.

While contemporary science is the progeny of the marriage of government and university, civil technology is the child of industry. Private industry provides the most successful machinery in our system for developing technological innovation. Since acceptable solutions to many social problems will require technological advances and even breakthroughs, industry will play an essential role.

The typical large company considers that its primary social responsibility is to make profits that will permit it to pay taxes to the government and dividends to its shareholders so it may continue in busi-

ness, continue to develop and employ more people who in turn pay more taxes. If a company persistently loses money it will ultimately fail.

Like any biological or institutional organism, industry is primarily committed to its own survival, which means the earnings of profits, consistent with the law (or occasionally inconsistent with it). This can place it in incongruous situations where, although it is operating in the public interest by providing jobs and generating taxable profits, it may be working against the public interest by polluting the environment, blighting the countryside or destroying amenities.

This is because industry relies on the marketplace to measure the usefulness of new products to the user. In contemplating new investment, industry assesses the potential of a new product by cost-benefit calculations based on market studies. It does not measure potential damage to others or to the environment. It rarely has occasion to consider side-effects and long-range consequences, but only reflects consumer preference. The reasons for its narrow assessment is that the existing legal order determines which costs and which benefits are to be taken into account and which ignored. For example, a power company treats the fuel it consumes as cost, but ignores pollution because it generally is not required to pay for cleaning it up. A public relations problem might occur, but this affects the company only because it fears that public opinion might cause a change in the laws.

For these reasons, pollution is a "social" or "external" cost rather than a business or internal cost, but only because and to the extent that the legal system so decrees. The system of markets and prices is modified and sometimes replaced by government intervention. Control is exercised through the patent system; through government financing of technical projects in industry; through regulation of certain industries by government; and through government's direct involvement in technical programs in areas like housing, highways, water resources, agriculture, aviation and military equipment.

The fact is that industrial growth contains intrinsic penalties in injury to the physical and man-made environment and to the physical and psychological health of populations. Yet it is the limiting factor that defines the total resources available for the achievement of social goals and may indeed be a precondition rather than a deterrent for their realization.

The reason for this is that continued growth is going to be necessary if we are to shift the emphasis of our present allocation of resources to a distribution more responsive to contemporary needs. Present claims on available financial resources preclude major new efforts until the middle of the decade. Anyone expecting significant replacement of programs underway underestimates the inertia and the virtual immortality of large government institutions. Vested interests will not easily allow short-term changes in the claims on our financial resources. If we are realistic, we shall not count on diversion of huge military budgets to civil programs. So it would seem that we must rely on growth.

Technological innovation is an important stimulant of growth and therefore a motivating force for the necessary shift of emphasis. If priorities are to be reordered so as to make the quality of life a major national goal, technological innovation must be encouraged as a matter of national policy, although on a highly selective basis. Beyond this, we rely on new technological developments to compensate for our high standard of living and wage rates through the greater industrial efficiency necessary to remain competitive internationally. To these ends a great deal more must be learned about the poorly understood subject of the relation between science and technology on the one hand and economic factors on the other.

Industry is bound to play an important role in the shift of emphasis. It has the advantage of considerable flexibility as compared to government or universities and can be relatively quick in responding to perceived opportunities.

But until industry sees public needs as markets, there is no incentive for it to be a real participant. The help of government is necessary to define market opportunities and to lend them stability as credible, long-range prospects for industry.

Before investing, an industrial executive wants to know who the customer is, what his requirements are and how long he will have them. Unfavorable answers can deter investment. With regard to investment in civil systems, there may be uncertainty about government interpretation of antitrust laws and regulations in cases where products and services from different companies, or a pooling of resources, are required. The reluctance of many government departments to award research grants to industry in favor of universities and nonprofit organizations is a deterrent to investment, as is the confusion of varying regulations and standards from one local jurisdiction to the next. Resolution of these issues can help bring the formidable resources of American industry to bear upon our most pressing problems.

### *Social Systems*

One of the great deterrents to the realization of social objectives is the absence of an adequate understanding of social systems themselves. Sociologists of reputation freely admit their shortcomings in describing social phenomena, let alone predicting them. To quote one of them, Fredrick Bates: ". . . any re-design of our present society along Utopian lines would have to be done largely on the basis of beliefs, values, prejudices and preferences rather than on scientifically reliable knowledge."

To make matters worse, we hear misgivings from respected authorities about the applicability to the social domain of the procedures, approach and even philosophy which have led to such spectacular progress in the understanding of nature. Some maintain that no amount of mathematical refinement will permit the application of the methods of the physical sciences to the social sciences. This thinking is quite independent of the fact that in some problems of social change — such as the migration of blacks and Puerto Ricans to New York City — the data may change significantly before the study can be completed. It is rather based on a conviction that an entirely new meth-

odology must be invented and that the social sciences have been set back 50 years by their espousal of the epistemology of the natural sciences. Nonetheless, advances in computer technology make possible more elaborate simulation studies and mathematical models, using the old methods. Economists and operational researchers use them all the time.

### *World Dynamics*

I should like to mention one computer approach, not necessarily because I believe it, but rather as an example of the extreme results which we should both listen to and be wary of. This is the systems dynamic method of computer modeling developed by Jay Forrester of the Massachusetts Institute of Technology, who applied it first to the industrial environment, then to the urban environment and has now extended it to what he calls World Dynamics. His computer models of industrial, urban and world complexes differ from those commonly applied in the social sciences. Whereas the usual models are statistically derived from data, Forrester's models contain "a statement of system structure." He maintains that this type of model explains our present difficulties with real social systems and why so many efforts to improve them have failed.

The model of World Dynamics unfolds scenarios in which technology threatens to spell the decay of civilization as we know it by artifically permitting industrial expansion beyond the exhaustion point of natural resources. Forrester first examines a situation in which declining resources and the consequent fall in capital investment are a limiting factor to industrial growth. There will be spontaneous pressure to reduce world population, and the model predicts a population peak limited by economic factors in the year 2020.

This, however, would be one of the more desirable forms of the inevitable limitations on population growth foreseen by his model. Science and technology can be expected to find some substitutes for natural resources. Thus depletion will not have the normal limiting effect on industrial expansion, and eventually on population. Industrial growth would continue, capital investment would rise, as would the population, until a pollution crisis (instead of economic factors) intervenes to reduce birth rates, increase death rates and reduce the food supply. This would not be a minor dislocation but rather a catastrophe in which the population, peaking in the year 2030, would fall to one-sixth of the peak value within 20 years. So the technological success of replacing natural resources would lead, according to this model, to a pollution disaster. This is an example of how the treatment of symptoms (depletion of resources) of a short-range problem (lowering of living standards) can create worse long-range trouble in other parts of the system.

Forrester's World Dynamics is highly controversial among professional operations researchers. But there are other scientists of considerable reputation who profess genuine fear for the survival of the human race. Yet the resourcefulness of man and his adaptability as a biological organism are awesome. As Philip Handler, president of the National Academy of Sciences, reminds us:

> Primitive nature is largely hostile to man and subject to wide fluctuations due to natural cataclysms. . . . It was the natural forces of physical and biological evolution on this planet which extinguished at least 90 per cent of all species that have ever appeared on the face of the Earth. But man, uniquely, is the first species which can control his own destiny and that of all other living forms.

We must listen to those who defy conventional wisdom, for they may be just the ones who can pipe the tune of the future. We must test all intellectually respectable lines of inquiry, while keeping in mind that, as the great Danish physicist Neils Bohr said, "it is very difficult to predict — especially the future."

As presently organized, our government structures are not necessarily appropriate to their tasks. Donald Schon has referred to them as "memorials to old problems," the point being that the rate of change in human affairs is today so great that once a problem has been recognized and acknowledged to the extent that solutions are developed, that very problem is already overtaken by events and is no longer a valid statement of need, so that the solution is obsolete.

### *Technology Assessment*

For the present, however, we must make the best of those institutional arrangements that we have. One scheme for doing so, called "technology assessment," is undergoing promising development. Technology assessment was born because a need was perceived by former Con-


**"Miles per gallon? That's another thing that's new. It gets 1,500 YARDS per gallon."**

gressman Emilio Daddario, then chairman of the Subcommittee on Science, Research and Development of the House Committee on Science and Astronautics, for a resource available to Congress which would provide adequate and objective information for evaluation of the total impact of new technological developments proposed for the government to undertake. Such information is required for a political decision and therefore cannot be confined to the usual economic cost-benefit. It must include social as well as economic and technical factors — not an easy order.

A series of studies on technology assessment was commissioned by the Committee. One was performed by the National Academy of Sciences, another by the National Academy of Engineering and a third by the Legislative Reference Service of the Library of Congress. Together these exploratory reports form a conceptual basis of technology assessment by providing, respectively, a philosophical framework, sample assessments of current choices and case histories of past choices. Out of all this has emerged a methodology, described by Dr. Chauncy Starr, dean of engineering and applied science at the University of California at Los Angeles and chairman of the committee which produced the NAE report:

1. Identification of the subject to be assessed.
2. Delineation of the scope of the assessment.
3. Development of a data base.
4. Identification of alternative strategies to solve the selected problems with the technology under assessment.
5. Identification of parties affected by the selected problems and by the technology.
6. Identification of the impacts on the affected parties.
7. Measurement of the impacts.
8. Comparison of alternative strategies.

The NAE set up three task forces to do experimental technology assessments in three areas. Testimony of their success lies in the fact that in one of the studies certain needs were identified which had not previously been recognized, and others came up with findings that had been overlooked by related studies that had not been focused by the methodology of technology assessment.

But technology assessment can be expensive, it can be long, and its conclusions may not be accepted. For example, the only full-scale technology assessment of which I am aware has taken two years and cost $2.5 million. It was done by the Third London Airport Commission which was assigned the unenviable task of recommending a site for a third major airport to serve Britain. Ecological, amenity and social values as well as economic considerations were assessed for four sites, narrowed down from 70 sites that included public suggestions. An elaborate procedure of cost-benefit analysis was developed and applied. The crucial factor differentiating the final two site choices to which the analysis was reduced turned out to be costs, in time and transportation, of access by the passengers to the airport site. The difference in cost between the two sites came to some $700 million. This amount would provide the equivalent of 100 new hospitals in a nation where new hospitals are badly needed.

### *The Will of the People*

When the decision was announced, it was not unanimous. The dissenter was a prominent urban planner, Colin Buchanan, whose wife is a well-known conservationist. In a separate report, he took exception to the majority choice of an inland area near the town of Cublington in Buckinghamshire, principally because of the destruction of rural land and of old architectural gems which dot the area. He preferred the next contender, a site off the shore of the east coast of Essex bearing the unseemly name of Foulness. Conservationists and the residents of the Cublington region raised a public outcry. The result is that despite two years work by acknowledged specialists at considerable cost, the government finally decided against Cublington. Of course the outline I have presented is extremely simplified, but a point remains. This point is that one can assemble experts with impeccable qualifications who use the most advanced techniques to arrive at results which have proven to be logically unassailable, but nonetheless turn out to be against the will of the people as interpreted by the government.

Yet even if its recommendations are to be ignored at least one sizable advantage was derived from the study. As a result of information uncovered during the hearings, revisions were made of the estimated timing of the need which was extended by a decade from original claims. At some $50 million annual savings because of this delay there is an impressive total saving of $500 million.

There are other examples. The great heart surgeon, Michael DeBakey, was concerned about disseminating medical developments from the centers of learning and research to the outlying areas of Texas and the nation. A scheme bearing his name was supported for this purpose by the federal government to the extent of $100 million annually. But local medical authorities had their own ideas about how the funds should be used. As long as close supervision was exercised, the funds were applied as intended, but this was not possible on a permanent basis, and the program was finally subverted.

These two examples bring up the question of collective choice: How do we know what groups, communities or nations really want? And if this can be determined, is what they want really good for them? If not, how can they be persuaded so? We have relied upon and must continue to rely upon, the political process to serve these functions in a democratic society of informed and reasonably educated individuals. But we can improve the tools serving this process.

In his remarkable film series entitled "Civilization" the British art historian Sir Kenneth Clark tells of Leon Alberti, the quintessential Renaissance man, as having said, in the serene confidence of the capabilities of his day, "A man can do all things if he will." Clark says this could be the motto of Alberti's age. I would ask: "Can it also be the motto of our own?" There is only one answer: It must be.

# Will India Go Nuclear?

KRISH NANDA

*". . . Pressure on the government of India to go nuclear can be expected to increase with increasing nuclear developments in China. . . . And the government's resistance to going nuclear may be expected to decrease in direct relation to increasing disunion with the ranks of the Congress party and to the 'vote-catching' potential of the nuclear issue." Krish Nanda is assistant professor of political science at Loyola University of Chicago. This study was supported by the South Asian Institute and the Bureau of Applied Social Research of Columbia University and the Peace Research Institute, Oslo.*

**Technological contrasts in India.**

There are several reasons for being interested in the issue of nuclear weapons per se and in how the decisionmakers of a near-nuclear power view the issue as it faces their country.

The nuclear question is crucial in itself because of its momentous consequences, not only for the inhabitants of India whose representatives' opinions will be analyzed below but for the inhabitants of this planet. The issue is significant because it can provide a symbolic focal point for the fears and desires of the masses of a country whose elite suffered something like a "personal humiliation" at the hands of another, growing nuclear power. This issue is important because India is considered an nth country in the proliferation cycle, that is, if India goes nuclear there will follow almost inevitably a sort of "domino effect" or, what is called in economic development literature, a "spread effect."

Until recently nuclear defense for India was a nonissue in Indian politics. In government circles there was unanimity of opinion against nuclear armament. Among opposition parties, not a single one had declared itself in favor of a nuclear weapons system, not even the sturdily nationalistic Jan Sangh party.

Today the nuclear policy question has become an important political issue. It has been periodically raised ever since the Chinese atomic blast in October 1964, and it is likely to stay alive. The main reasons for this prognosis are: (1) there has been persistent demand for a review of India's nuclear policy since China's nuclear demonstration; (2) relations with China have not improved and are likely to remain hostile under the present circumstances and the foreseeable future; (3) finally, the Indian public is not only not opposed to a nuclear deterrent but positively favors it.

How do India's members of parliament view the bomb? To ascertain their opinions, a scientifically chosen representative sample of 119 was interviewed. The findings indicate that the elite stands transfixed: to be or not to be.

Responding to the question of whether, taking everything into consideration, they thought it would be an advantage for India to have atomic weapons, the results were almost equally divided: 49 per cent were against and 47 per cent for India having a nuclear deterrent. The remaining four per cent were undecided.

There was an almost complete division of opinion within the ruling Congress party (46 per cent for and 49 per cent against, the rest undecided), followed by the right-wing Swatantra party (36 per cent for and 55 per cent against). There was more or less a consensus of opinion among the respondents of the other parties: Jan Sangh along with the Left socialist parties (Praja Socialist Party and Samyukta Socialist Party) favoring the proposition and the Left communist parties (Communist Party of India and Communist Party, Marxist) against it. There is thus ideological criss-crossing on the issue.

The majority feeling in the Swatantra party is against India having a New Delhi-based deterrent. While its members, in common with other pro-bomb lobbyists, fear Chinese intentions, they reason that it is useless to have a third-rate nuclear capacity to brandish against China. It is suggested that, economically, India can ill afford nuclear armaments: such a program is bound to result in a setback to India's economic development. Also, to follow the nuclear path is to forsake "our sworn principles."

On the last item, Swatantra and government party respondents are in agreement: a plurality in the latter also thinks that to go nuclear is to forswear Indian traditions and po-

litical heritage, from King Asoka to Ghandi. But government (that is, the plurality in the ruling Congress party) does not go along with the Swatantra party in its suggestion to negotiate for the American deterrent. Joint nuclear guarantee by the two superpowers is regarded as an impossibility by Swatantra respondents: Russia would not ally with the United States to form a nuclear bloc against China. Also the two may disagree in the hour of India's need. The American umbrella is considered an effective deterrent against possible Chinese bad intentions. "What China would then face is not partial loss or damage to which it may easily reconcile itself, but something more terrible which it would really fear," calculated a Swatantra respondent.

The members of the government party feel that to accept U.S. nuclear protection is to compromise neutrality, which is crucial to India's political role of a mediator between East and West. For Swatantra members nonalignment has already lost meaning in the context of aggression against India by a communist power.

The objections of the respondents of the ruling party to India going nuclear are similar to those of Swatantra respondents. They do not, however, opt for nuclear protection from the United States or the Soviets or both: their policy position is to eliminate the world stock of nuclear weapons. "That has been our position all along. . . . And that's our best defense," remarked a front-bench member of the Congress Parliamentary party.

India's defense needs are best served, according to the respondents of the ruling party, by conventional weapons, equipment for mountainous warfare and good soldiers. "What you need is good soldiers and we have them. The Chinese, too, fight fearlessly and challenge everyone, including America and Russia, who have superior weapons but dare not annoy China. So it is not weapons, but men, that act as a meaningful deterrent, my dear friend," concluded an informant.

This "group" of respondents might as well have used Francis Bacon's words: "All this is but a sheep in a lion's mouth except the breed and disposition of the people be stout and warlike."

Such a policy position gains additional meaning in the present context of feeling prevalent among all the elite respondents that if there is a confrontation with China, it will be of the conventional type. China, said an informant, will fight one of those "frontless" wars. Very low probability is assigned to a nuclear war in which only India and China might be involved.

In common with the Government party, the elite respondents belonging to communist parties are against India's nuclear arming. They, too, would like to see India's scarce resources devoted entirely to the welfare of the poor. They agree with the government that there is no functional necessity for a nuclear deterrent. They expect no invasion from China. But whereas these informants read Chinese nuclear demonstrations as a challenge to the West and not really to India, the respondents from the ruling party do recognize that China's nuclear development has posed a big political challenge to India and won China a lot of political and symbolic mileage. "Politically, our stock is low," admitted a former front-bencher.

The two "right" groups, Jan Sangh and Swatantra, take opposite positions on nuclear weapons, but both admit, in contrast with the communists, that China could pose a nuclear threat to India. They differ, however, in their strategy: Swatantra, as noted earlier, favors a foreign-based, American, deterrent; Jan Sangh prefers a home-based deterrent, arguing that a foreign-based deterrent is "a risk and a gamble." "There is no substitute for your own strength," advises a Jan Sangh leader. This is particularly so in the atomic age, where speed in defense is crucial. A country can "meaningfully" defend itself only if it has its own deterrent power: only then does it have the possibility to deter the potential aggressor from his offensive intentions.

In line with Jan Sangh respondents, the respondents from both socialist parties favor India going nuclear. But there are differences of style and spirit between the former and the latter. As a policy object, the issue of nuclear weapons has high centrality for Jan Sangh respondents. They manifest intense and persistent interest in the matter which makes one think that the question has become for this party some sort of an idee fixe in the foreign policy sphere. Respondents from other pro-weapon parties differ in the sense that the issue does not elicit the same durability and salience of interest from them as it does from Jan Sangh members.

What makes the issue central for Jan Sangh? Perhaps the answer lies in their aspirations for a strong, self-reliant India. To Jan Sangh, national independence and sovereignty is most clearly epitomized in national unity and territorial integrity. A strong defense is a matter of national identification and pride: national security is the mainstay of national values. Self-dependence, self-defense and rejection of foreign protection are objects associated with the attainment of basic values; to the extent that they are construed as means to basic values, to the extent that they are tied to primary goal state, these objects take on the same centrality as the primary goals of national policy.

Of course, the desire to build a strong, self-reliant India is common to all parties. But this desired goal has no immediate linkage with the nuclear weapons issue. Hence the issue lacks for them the goal utility which it has for Jan Sangh.

### *Proponents and Opponents*

Both sides share the feeling that possession of the nuclear bomb has given China a decisive political (as opposed to military) advantage. The "status gap" between India and China is recognized and the desire to achieve status parity is evident.

Those who oppose atomic weapons think that the way to gain influence and respect for India among the family of nations is to develop her economic and industrial potential. "Don't you know that Americans had their priorities straight: they had their economic revolution before they proceeded to world politics. We, here, want to dabble in world politics without the economic wherewithal," lamented an antagonist of nuclear weapons for India.

Moreover, there is practical intelligence. "We are a nonaligned and nonviolent nation. We will be neither if we develop nuclear war-

heads. A successful use of nuclear weapons presumes embarking on a preventive war: that is, dropping a bomb before another drops on you. This we won't do. Never. No government in India, Congress or non-Congress can dare to do that. So, why have a bomb?"

Finally, if one must go in for atomic armaments, one has to do that on a large scale to be effective. "This we simply cannot do unless we are willing to starve ourselves, which means weaken ourselves by strengthening India's nuclear capability." That is essentially the case that opponents of the bomb make.

The proponents see no conflict between solvency and security. They feel that even a semi-deterrent well within India's economic reach will serve the same purpose as a big nuclear capability. It will create doubts in the minds of hostile neighbors. "It is uncertainty which is the essence of deterrence," was the way an advocate of Indian nuclear power expressed it. India's image will be enhanced. She would not need to match her nuclear capabilities with those of China; the mere possession of nuclear weapons has an "equalizing effect."

Defense and development are not seen to be contradictory by the advocates of nuclear deterrent. The nuclear program is regarded by many bomb lobbyists as having contributed to the prosperity of France. "What we will do is to shift Indian economy from its lopsided consumer orientation to emphasis on capital goods production. The political support of the Indian trade unions could be enlisted in this regard," suggested a respondent.

Even if the aid-givers will be displeased by India going nuclear, they would not sever economic and political relations with India simply because India decided to make the bomb. "By what possible moral argument can an aid-giver condemn the other nations for acquiring things which they themselves have sought and got?" demanded a respondent.

Thus, nuclear weapons are seen as primarily political weapons. This is conceded indirectly by the respondents from the government party, as well as by some other opponents of nuclear weapons, when they admit that China's basic purpose was to gain big-power status by breaking the Western nuclear power monopoly. That she has been successful in her design is conceded — sometimes grudgingly by the government party. Both sides also think that technically the bomb is within India's reach. The urge to achieve parity in influence with China is also common. Both sides are on the same ground when they regard as exceedingly small the probability of an unconditional response by a possible "guarantor" against nuclear threat to India. The desire to keep the nuclear option open for India commands a broad consensus too. In fact, this attitude lay behind the package of arguments advanced by the government of India against becoming a party to the Non-Proliferation Treaty (NPT).

### *The Future*

At present the distribution of opinion is such that there is much disagreement in the ruling party and much disagreement among the opposition parties. In other words, the "ins" and the "outs" are not arrayed against each other. So while the issue or a bill embodying a precise nuclear program is likely to provoke much debate, it will not in all probability polarize the political leadership.

The data indicates that the Indian elite stands at the crossroads. The broad sentiment reflected is that of rueful support and genuine reluctance. However, pressure on the government of India to go nuclear can be expected to increase with increasing nuclear developments in China; with any one or two or more countries becoming nuclear; and, to a lesser extent, with "vertical" proliferation — the continuing manufacture of nuclear weapons by the nuclear states. And the government's resistance to going nuclear may be expected to decrease in direct relation to increasing disunion within the ranks of the Congress party and to the vote-catching potential of the nuclear issue.

But why, possibly, will India go nuclear if it goes at all? Those among the respondents (in the ruling and opposition parties alike) who are against India going nuclear are also against any nuclear protection from abroad, by a majority of 82 per cent to 18 per cent. It would seem, therefore, that a nuclear guarantee is not regarded as a substitute for a nuclear deterrent. Hence, if India decides to become a nuclear power, it would not be because no nuclear umbrella existed. That is irrelevant. If India mounts the nuclear horse, it will be in quest of rank, of lost standing in the family of nations.

It is an axiom in social theory that an actor in a structurally differentiated system is likely to assess the prevailing distribution of power and take steps, in view of the possible vertical mobility, to alter that distribution in its favor and thereby enhance its power-political rank. Two recent examples from current history in support of the theorem at the international level are China and France. Both of them felt that their power share in the international system was clearly less than proportionate to their size and historical importance. And both of them have sought to alter that distribution of power. On the basis of support provided by this theorem and historical evidence, it can be conjectured that if India goes nuclear it will not be for reasons of security but of status.

This thesis acquires additional credence in view of India's refusal to be a part to the NPT. The government's whole case against the Treaty was centered on the "inequalities" that lay embedded under the skin of the Treaty and its "haves and have-nots" character. The data also indicated that the military value of the nuclear deterrent is considered secondary because it is assumed that likelihood of actual use of nuclear weapons in a war is small in contrast to their regular use in diplomacy. China's accession to the atomic club is considered to have conferred on her an aura of triumph and sent her many notches up the international hierarchy while disequilibrating India's status. As Professor Hans J. Morgenthau has said: "Nations, which as members of the international society must in the main rely upon their own power for the protection of their existence and power position, can hardly neglect the effect that a gain or loss of prestige will have upon their power position on the international scene."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JAMES J. NAGLE

# Genetic Engineering

*"Modern genetics is on the verge of some truly fantastic ways of 'improving' the human race, but . . . this technical know-how does not automatically bring with it the criteria for its use. This, I believe, is the most important fact that scientists and citizens alike must keep in mind as our technology progresses." The author is a member of the department of zoology at Drew University, Madison, New Jersey.*

Man is on the verge of a biological revolution. Modern biology has opened a Pandora's Box of possibilities for man to manipulate and control his own development and the future evolution of his species. As Robert Sinsheimer of the California Institute of Technology has pointed out, "the possibility of genetic engineering is one of the most important concepts to arise in the history of mankind because, for the first time, a living creature understands its origin and can undertake to design its own future."

To understand the possibilities of genetic engineering three aspects of the problem must be considered: (1) the biological basis upon which the possibilities are founded, (2) the types of engineering being considered and (3) the circumstances which might prompt the use of genetic engineering by man.

The biological basis for genetic engineering began in the mid-nineteenth century when the Austrian monk Gregor Mendel discovered that some sort of hereditary factors operated in a predictable fashion to determine the characteristics of an organism. Subsequently Mendel's factors were named "genes" and were shown to reside on the chromosomes in the nucleus of the cell, the structural unit of living organisms. In 1953 James Watson and Francis Crick launched the molecular phase of genetics with the proclamation that DNA (deoxyribonucleic acid) was the genetic material. DNA represents the chemical thread of genetic continuity across the generation gaps. This macromolecule of nucleic acid is constructed of sugar, phosphate and nitrogen base compounds bound together like a twisted ladder into the famous double helix. Four different nitrogen bases form the cross-rungs of the ladder, and it is the long sequences of these bases which make up the genetic code. Each protein and enzyme produced in our body is the product of a specific code for its construction. If the code is slightly altered this may make the end product inactive, resulting in an alteration referred to as a mutation. A mutation, then, is a change in the genetic code. Changes in the genetic code brought about by irradiation, chemical compounds, including drugs, or physical alteration may produce an array of effects ranging from blue instead of brown eyes or attached rather than free ear lobes to severe genetic diseases such as PKU (phenylketonuria) or hemophilia. Our understanding of gene structure and function is now detailed enough so that goal-directed manipulation of the hereditary process has led man to the threshold of genetic engineering.

### *Euphenic Measures*

Genetic engineering can be considered to operate at two levels. The first is that of improvement or treatment of genetic defects for the benefit of the afflicted individual. Engineering at this level is called euphenics and consists mainly of correcting genetic deficiencies by supplying some product which is lacking due to a malfunctioning gene. Supplying insulin to a person with diabetes mellitus is a euphenic measure. Treatment such as this only alleviates the symptoms for the individual; it is not a cure. As a result, the afflicted person may still pass his genetic abnormality on to his children. In fact, by saving the life of a person through treatment of a genetic disease his subsequent reproduction then increases the frequency of that gene in the next generation. As medical science is able to treat more and more genetic defects the frequency of those defects will increase in future generations. A compounding of this phenomenon is what leads many geneticists to worry about the gradual genetic deterioration of man. In fact, it has been estimated that, at our current rate of medical advancement in the treatment of genetic defects, within five to ten generations (75 to 150 years) one out of every ten children born will have a serious defect of one kind or another making them dependent on medical technology for their existence. This presents another serious pollution problem for man to wrestle with — the pollution of his gene pool.

Nevertheless, much current research is aimed at more sophisticated and effective euphenic measures. Taking diabetes mellitus as our example again, the genetic defect is a deficiency in the production of insulin by the pancreas gland; hence, a treatment much more effective than daily injections of insulin would be to put operative genes for making insulin into the pancreas and have normal production restored. Let us see what this would entail.

It would first require identification of the exact structure of the

insulin molecule, which is a proteinaceous hormone — a gene product. This has already been done. Next we would have to know the genetic code words for each component of the molecule; the code has been deciphered and the genetic dictionary is complete. Next we would have to be able to synthesize a segment of DNA representing the specific genetic code for the insulin molecule. Man-made DNA has become a reality, although refinement of the technique is needed before a specified gene can be artificially synthesized. Alternatively, the technique for isolating a specific gene from simple organisms such as bacteria opens the possibility of selecting a "ready made" gene with the desired function. In either case the specified gene will ultimately have to be put into the cells of the pancreas where the production of insulin occurs. A mechanism for accomplishing this step exists and current research is aimed at "domesticating" the process for human use. The mechanism is viral infection. When a virus attacks a host cell and reproduces itself, sometimes genetic material from the host gets incorporated into the newly produced viruses; then when they attack another host cell the genetic material from one is transferred to another. This mechanism is called transduction. The objective is to evolve a nonpathogenic viral strain which can transduce selected man-made or isolated genes into specific cells, such as those of the pancreas. There they would then take up their normal function — in our example insulin production.

### *Viral Transduction*

This final step, which makes the whole scheme operative, is now close at hand. The feasibility of viral transduction became apparent in the mid 1960s when some researchers at the Oak Ridge National Laboratories in Tennessee accidently provided the critical evidence. During their annual physical examinations it was discovered that they had an abnormally high level of an enzyme called arginase in their blood stream. Further investigation revealed that all these individuals had been doing research on a rabbit virus, and it was concluded that they had been infected by the virus, which had transferred into the researchers some of its DNA containing the genetic code instructions for a cell to make arginase. Arginase is an enzyme normally found in man, that is, we have a human gene responsible for supplying this enzyme to our body. Defective forms of the human arginase gene cause a genetic disease which is characterized by a lack of arginase in the blood and severe mental retardation. Thus, it seems plausible that the rabbit virus injected into humans lacking arginase might be able to provide the gene needed for making the enzyme, thereby preventing the mental retardation. Just recently two little girls in West Germany suffering from arginase deficiency were infected with the rabbit virus from Oak Ridge in an attempt to correct their defect — the results are still pending. A virus with the requisite DNA for insulin (naturally occurring or man-made) should be able to treat diabetes in a similar way.

### *The New Eugenics*

The second level at which genetic engineering is aimed is that of the general improvement of the genetic make-up of the human race as a whole. This is the populational level and may be considered as the new eugenics, that is, the modern approach to selective breeding in man. Modern genetics is on the verge of some truly fantastic ways of "improving" the human race, but let me emphasize at the onset that this technical know-how does not automatically bring with it the criteria for its use. This, I believe, is the most important fact that scientists and citizens alike must keep in mind as our technology progresses. It may be true that man has tremendous genetic potential for significant improvement, but in what direction? It is tempting to point to the great success animal breeders have had in "improving" their stocks and say that the same can be done in man, but we must remember that animal breeding was successful only because the breeders had a Platonic "ideal" and selected ruthlessly for uniformity to achieve it. It seems certain that the improvement of man does not lie in some simple uniform ideal analogous to the ideal dairy cow with her "opulent udder." There probably are human characteristics, such as mental ability and overall achievement, with complex genetic bases for which improvement would be desirable. But it is important to recall that a person must live his whole life before any meaningful value judgment can be attempted for such nebulous characteristics. Modern genetic engineering techniques make it possible to wait for the final judgment of a person's character before selective breeding is done.

Let us consider some of the techniques that are at the forefront of current research. The first is artificial insemination, where sperm cells are implanted into a female at ovulation to fertilize her egg cell. This method is in practice now, and for the last five years at least 10,000 babies per year have been produced in the United States in this manner. This practice at present is not controlled and no goals other than baby production seem to be operating. The donor sperm comes mainly from the husband involved or from donors (commonly medical students or interns) who do not necessarily conform to most people's concept of the "ideal" human male. To control this technique the sperm can be frozen just as it is now for cattle breeding. Full term normal births have already been reported resulting from human sperm frozen as long as two years. An extension of these freezing techniques would make it possible to wait until a donor established his value to society through his life accomplishments before his sperm was used to "father" any children. Hence, selected sperm from "proven" males could be used to fertilize eggs to produce future generations with the expectation that genetic improvement would result.

### *Prenatal Adoption*

To complement this, artificial inovulation is now a reality. Here eggs are flushed from the oviduct of a selected female, fertilized by selected donor sperm and implanted into the receptive womb of another female. This "proxy" mother then incubates the selected embryo in the normal fashion, producing a child with a greater probability for genetic superiority than would be expected by

random breeding. This has been called prenatal adoption. An extension of this would be to fertilize a selected egg — which could also come from a frozen stock of a mother of proven value — with selected sperm in a test tube. During the early test tube development of the embryo genetic tests could be conducted to determine its sex and other traits. After passing these tests the embryo would be implanted into a proxy mother to complete incubation. After birth, the child's legal parents would be responsible for providing an environment conducive to the attainment of maximal genetic potential. The legal mother may or may not have served as the proxy mother. To this end, the birth certificate of the future has been envisioned as having as many as five parents: the legal father and mother, who raise the child; the proxy mother, who incubated the child; and the biological father and mother, who contributed the genetic material to the child.

### *Cloning Man*

Another quite different technique with which significant progress has been made in recent years involves asexual reproduction. This is essentially reproduction without eggs and sperms. The plucking of a leaf from an African violet to root and establish an entirely new plant in a separate pot is an example of asexuality. The significant feature of this mode of reproduction is that all the offspring formed are identical in genetic make-up to their single parent. Botanists use the word clone to describe the offspring of asexually reproducing plants. Now geneticists are considering the possibility of cloning man, that is, producing human offspring from cells of human tissue (somewhat analogous to plucking the leaf from an African violet) rather than through the fertilization of an egg by a sperm.

In this way the random assortment and recombination of the genetic material (the chromosomes) which occurs in sexual reproduction, even among selected eggs and sperms, is by-passed. As a result, once a person has distinguished himself as desirable to society his genetic endowment can be replicated by cloning. This would probably be done by culturing cells of the selected individual in a test tube until embryonic development is initiated and then implanting the embryo into the womb of a proxy mother to complete development. Since the chromosomes in the nucleus of every cell of the body contain the total genetic information which, in the fertilized egg, produced the individual in question, the objective of cloning is to maintain that "good" genetic complement intact by producing new individuals genetically identical to the selected parent. This technique also allows for evaluation after the life of the donor has been completed, in that tissue cultures can be established and even after death their genetic complement can be obtained from the culture.

Cloning is not a simple procedure. The problem is that when a complex organism develops and its cells specialize they lose the capacity to undergo the whole cycle of development again even though the total genetic material is still there; this is also the reason why man cannot replace complex body organs by regeneration. The trick is to unlock the control mechanism which turns off the genetic material in specialized cells and turn it on again to accomplish the development of a new individual. Serious consideration has been given to cloning since 1963 when F. C. Steward of Cornell University grew an entirely new carrot plant from a root cell. More recently, success was accomplished with complex animal tissue when J. B. Gurdon of Oxford University produced tadpoles and adults from the genetic material of a single adult frog intestinal cell. Research is progressing rapidly in this area and by the twenty-first century this technique will probably be applicable to man. The questions then will be, of whom do we make copies, how many copies of selected individuals do we need, and who is going to make the decisions?

Another research thrust of genetic engineering is the formation of hybrid cells. These cells are a combination of human genetic material with that of another animal species. Joshua Lederberg, Nobel prize laureate of Stanford University, has stated his belief that the day will come when man will be able to produce organisms consisting of man-animal mixtures of varying proportions. This, he says, could create a unique labor force or a ready supply of organs for transplantation into humans.

As the final aspect of human genetic engineering I would like to consider briefly the circumstances which might prompt the use of some of the techniques described above. The human population is exploding and sooner or later its unrestricted growth will have to be controlled if our species is to maintain or improve its cultural standards. Once birth control is established and the population size restricted, it will be very advantageous to have the highest quality possible among the individuals making up the population.

It is logical to assume that if methods to produce genetically superior individuals are available, and they certainly will be by the time man learns that he has to control his population size, they will be used. In the meantime, we must remember that man is not a product of genetics alone; his genes must act in some sort of environment. The more conducive to human development that environment is, the greater will be the degree to which all men will realize their genetic potential. Hence, what we can do right now to improve the human race is to provide the best environment possible. Once heredity has done its part, it is our responsibility as individuals and as a society to provide a proper environment. The technology and resources for this type of human improvement, called euthenics, are at hand today. Man has only to do it and it can be done.

JOEL DARMSTADTER

# GNP Does Matter

*An increasing awareness of environmental problems, and an attribution of blame for them to American economic policies, has led to a fashionable scoffing at "GNP worship." But correctly regarded, GNP is neutral and a useful economic tool. Attacking it can become a case of tilting at windmills — a pursuit that is at best useless, and at worst harmful in that it serves to obscure real issues. Economist Joel Darmstadter is senior research associate with Resources for the Future, Inc.*

The suddenly heightened preoccupation with the quality of life threatens with extinction a concept which, in my view, has not yet outlived its usefulness. I refer to gross national product — GNP — a statistical measure of society's production or consumption of all marketable goods and services.

The unquestionably legitimate insistence on broadening the standards of economic performance to include environmental and social aspirations frequently tends, nevertheless, to overreach itself quite unreasonably. To be specific, it has become fashionable in much of the current debate over environmental degradation to scoff at a rising GNP. A not uncommon tactic is to ascribe the straw man of "GNP worship" to hidebound economic policymakers and a misguided public and then to knock it down, a maneuver easily accomplished, given the fragile premise. Hence, a measured annual economic growth rate of, say, four per cent (the U. S. average for the past decade) is said to confer merely an illusory sense of progress, when accompanied by the demonstrable worsening in the quality of the physical and social environment which has occurred in the nation.

Take, for example, economist Robert Heilbroner's vision for the next decade as one which "will see an end to the worship of economic growth for its own sake. People will see the hollowness of numbers that show no real improvement in the quality of living." Or Wassily Leontief's indictment of the "Keynesians [who] thought that if you just produced enough, everything would be all right." More carping comes from Kenneth Boulding. The very title of a recent article — quickly borne out by the sniping that follows — sets the mood: "Fun and Games with the Gross National Product — The Role of Misleading Indicators in Social Policy." And according to the thesis advanced in E. J. Mishan's recent book, "Technology and Growth: The Price We Pay," an "overdeveloped" society, such as the United States, in failing to abandon the application to innovation and technology of traditional criteria of economic efficiency (which are unresponsive to external quality), is bound to record growth rates that, under any rational scheme, become progressively more and more meaningless. Somehow, one gets the impression from all this that, up until the awareness of the eutrophication problem in Lake Erie, we were all engaged in one vast saturnalia.

I cannot refute either the fact of the GNP growth rate, which is a matter of historical record, or the fact of qualitative neglect, which is a matter of sight, smell, sound and disheartening stories in the daily newspaper. (The conjunction of the two trends, of course, doesn't establish causality.) In filing this brief on behalf of GNP, I want merely to sort out some underlying points which may help provide a clearer, and less emotional, understanding of the central issues.

Let us, first of all, note that GNP is not claimed by its Commerce Department estimators to insure happiness or even satisfaction; it's not supposed to. Still, GNP does represent the wherewithal, whether it is now so deployed or not, for securing many things viewed as enriching one's chosen way of life — be they food and housing, chamber music concerts, national park visits, waistline manipulators and, not least, psychiatric services to find out why higher income isn't buying happiness. As voters and taxpayers, we can also elect — or be persuaded — to forego those things or additions thereto in favor of collective goods such as more public school capacity, sewage treatment plants and more defense spending. It's all in the GNP. Just remember, however, that GNP is "neutral" as to the degree of utility, disutility or diminished disutility which different persons see in its constituent parts. Many people would agree that expenditures associated with the first 3,000 calories of daily food intake are useful. For most adults, anything over 5,000 would be useless, if not positively harmful. The purchase of accident insurance policies illustrates the third category mentioned: inherently worthless in improving current living standards, they do protect us against the disutility of a potential disaster — dismemberment.

Incidentally, many who feel themselves enslaved to the GNP treadmill

can elect to trade off more material goods in return for more leisure time in which to contemplate the folly of their toiling fellow citizens. As it happens, most people exercise this option only sparingly: that is, people seem to prefer higher incomes to fewer working hours, laborers moonlighting as taxi drivers, university professors doubling as industrial consultants — you name it.

But even allowing for the indeterminacy of welfare inherent in GNP, and conceding that aggregate GNP masks distributive shortcomings, I believe that to dismiss a rise in real (that is, price-adjusted) GNP as a serviceable, if insufficient, proxy for enhanced living standards is to display a mixture of arrogance and mischief.

### *A Pointless Indictment*

Is it possible that the "hollowness" of incremental income is more apt to occur to a person with a salary well into five figures than to one who at $5,000 per year is still striving to provide basic necessities of food, clothing and housing? If you happened to have been among the nearly five million Americans who were unemployed in 1961 (800,000 of them for at least half a year), there was nothing ill-advised about policies that sought urgently to reverse the economic stagnation which had characterized much of the preceding decade. Does it make sense to persuade the nearly five million (or 10 per cent) of American families with average family income still below $3,000 that prospective growth of, say, four per cent in GNP (around three per cent on a per family basis) would no more contribute to an improvement in their status than would zero growth? Is it reasonable to deny the progress implicit in the upward movement of median family income from $7,000 in 1960 to $9,430 in 1969? (The figures refer to dollars approximating constant 1969 purchasing power.) That the statistically indicated improvement has failed, perhaps, to suppress an even faster rise in expectations, which some may presume to have given rise to social unrest, or that it has failed substantially to alter the shape of the income-distribution curve in America, all groups having moved up to higher income classes, may or may not reflect imperfections in the welfare implications of our social and economic system. But to lay such a finding at the doorstep of GNP measurement is quite a pointless indictment.

### *Criticisms of GNP*

The most pressing criticism of GNP — one of much prevalence — is that it is an indicator which somehow ignores the unmeasured, social (or "external") costs of producing and consuming the country's physical output. Raw sewage spilling into rivers, junk littering the countryside, noxious emissions from industry and transport, screeching jet aircraft, urban decay and many other forms of environmental degradation are said to be destructive counterparts, and therefore negative offsets, to measured production and consumption. All this is quite apart from their hazards to public health and even, in some cases, life support systems. Even when preventive or ameliorative measures are taken — as when wastes are recycled — the GNP critics frequently demur. In their view, a social accounting system which sums the value of economic activity that pollutes, on the one hand, to the cost of necessary treatment or abatement, on the other, betrays the ultimate absurdity. But here the critics ignore numerous other "plus" and "minus" spending items in the GNP: for example, excessive dietary indulgence versus reducing plans; or skiing vacations versus orthopedic treatment. It is also sometimes suggested, rather ambiguously, that allowance for polluting activities might yield a quantifiably "true" GNP growth rate below the rate actually measured — possibly to contrast our past profligacy of "free" goods like air and water with the charges which we will incur for their use in the future.

There is in all these viewpoints the implication that GNP growth and environmental quality are mutually exclusive objectives which need to be balanced off against each other. Other things being equal,

**"General Electric 56 — down 2; General motors 58 — down 1; Gould Battery . . ."**

while fast GNP growth is no doubt more of a threat to environmental purity than slow growth, it obviously does not thereby follow that growth retardation is necessary to improve the quality of life. Japan's phenomenal post-World War II GNP growth rate seems to have been achieved with remarkable disregard to mounting problems of air and water pollution. By contrast, India's growth rate has clearly not been held down to its much more modest level in the interests of the country's environmental quality which, in some respects, is perhaps worse.

There is no reason why a diversion of resources from the production of frills to the production of, say, sewage-treatment facilities necessarily involves a retardation of GNP growth. Nor is there any reason to suppose that, short of such a redirection in the components of GNP, it would make much of a difference to the quality of life whether we grew at four or at three per cent per annum. (It is worth noting that, in the face of rising productivity, a halt to population growth — frequently viewed as the chief agent in environmental deterioration — would still mean GNP growth of perhaps two per cent per year.) Indeed, even a zero rate of growth in GNP holds no assurance that a cumulative despoliation of the environment will not upset the balance between economic activity and the ecological system which we seek to preserve.

It is debatable whether an all-encompassing GNP measure can be perfected which would bring these issues into the desired degree of perspective; a quantitative adjustment incorporating the different forms of environmental damage or numerous other undesirable or, for that matter, desirable consequences of economic behavior (GNP is neutral, as we noted earlier) seems like a tall statistical order. I do not deny that, as a result of our pattern of national consumption, we incur visible and invisible unpaid, though still real, costs — possibly of enormous magnitude. But even if, say, the fish kill of a river polluted by industrial effluents deprives fishermen (and the nation) of a determinable amount of net income, an operationally feasible means by which to make some corresponding change in GNP is not in sight, although I do not suggest that efforts to construct such a device may not some day succeed.

Analogous to our inattention to what is happening to the environment, failure to divert more funds to education, investment, public transport or other sectors of the economy can have similar, though equally "unadjustable" effects, the more so when psychic or aesthetic values are involved. Proposals by economists that environmental damage to nonmarket assets (physical as well as aesthetic) be treated akin to depreciation of business capital assets have so far failed to grapple with enormous problems of concept and measurement.

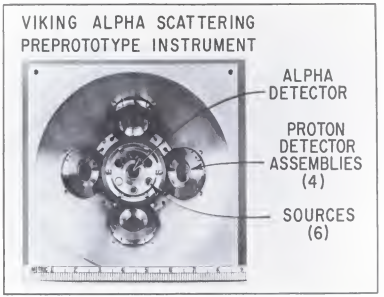
### *Exploring Directions*

All this is not intended to downgrade the importance of speculating on, and analyzing, the direction which such reallocation of national resources might take and the way it would interact with the growth of the nationwide economy. On the contrary, I believe it is important to explore alternative degrees to which our patterns of consumption might suitably be redirected to achieve specified aesthetic or physical objectives, such as clean water, improved health, better housing and so on. This need not be a sterile exercise if it helps indicate the amount of "give" there is within our present economic mix, to achieve defined goals.

From a more narrow accounting standpoint, the government's national income estimators could also make a useful contribution by detailing much more specifically than is now the case those activities within the GNP that are particularly injurious to environmental quality. Such a task probably could not avoid some value judgments, and it might require the assistance of scientific experts who would go on ("outside" the GNP accounts) to "cost out" alternative ways of meeting the environmental damage. Since GNP refers to final output, input-output analysis, focusing on the intermediate product content of GNP, could also be of great assistance. But since what I suggest here is a matter of reclassifying and dissecting rather than recalculating the GNP, the integrity of the latter measure would remain intact.

It is not my intention to dispose too cavalierly of measurement issues which may arise from concern with environmental issues even in conventional GNP accounting. To name only one such problem, adjustment for price changes so as to yield changes in the value of "real" GNP poses technical difficulties. Assume, for example, that resources are diverted into electric-power production in order to limit sulfur emission and thermal discharge. Embodiment of new desulfurization processes and cooling-tower equipment may raise the price of electric power (by up to 25 per cent, according to some estimates) even though the final product, electricity, remains, to all appearances, unchanged in quality. After all, a kilowatt is a kilowatt. Is the real value of electricity output unchanged? If so, a decline in real output in the area from which productive resources are diverted may mean that overall real GNP is down — a perverse result. In addition, there are persistent controversies in social accounting which may have particular relevance to environmental quality: for example, treatment of depreciation, depletion, appreciation and imputed income (as from parks and open land). Clearly, serious conceptual matters remain to be wrestled with.

In conclusion, and without belaboring the obvious, I submit that there is no use condemning GNP for failing to possess attributes that mirror defects in our society. It is primarily an economic, and not a social, indicator. While admittedly limited in scope, GNP nontheless constitutes one important and, in my judgment, faithful aggregate measure of America's record and level of economic achievement. It should be neither extolled as the ultimate measure of man's glory nor abused as superficial and meaningless. Instead, thoughtful analysis would use the GNP as one tool, among others, in assessing the nation's capacity to reallocate its resources so as to diminish the very deficiencies in our life which the emphasis on GNP is presently alleged to obscure.




# Getting Aboard Viking: No Room on the Mars Lander

*On Saturday, November 13, Mariner 9 encountered Mars. This was the latest American attempt to explore another planet. Mariner 9 was loaded with instruments to map the surface for future touchdown sites and record data for clues to the possibility of life on the red planet. The next Mars investigation is planned for 1975 when two Viking spacecraft are due to be launched to the planet with landing capsules. Already scheduled aboard the Viking landers are instruments designed primarily to seek evidence of life. However, there is another aspect of interplanetary exploration that may not be carried out on the first soft landing as illustrated in the following report.*

Anthony Turkevich whose team of researchers built the first moon soil analyzer for Project Surveyor is hoping to put another little gold box on the first American Mars landing probe in 1975. "I'm trying to get aboard," said Turkevich, professor of chemistry at the Enrico Fermi Institute for Nuclear Studies at the University of Chicago. So far he hasn't been successful. The focus of the scheduled Viking payloads is on life detection experiments.

Wearing a string tie and blue-checked sports shirt, Turkevich exhibits the relaxed air of a Colorado vacationer rather than the intensity one might expect of a scientist working on a highly sophisticated interplanetary instrument. Turkevich's box, which is about three inches per side, is capable of recording the most abundant chemical elements in soil and transmitting the data back to Earth by radio. First used on Surveyor 5, a moon landing probe, it relayed to earthbound scientists the first chemical analysis of the lunar soil. Later analyses of soil samples from the Apollo 11 mission generally confirmed the box's findings.

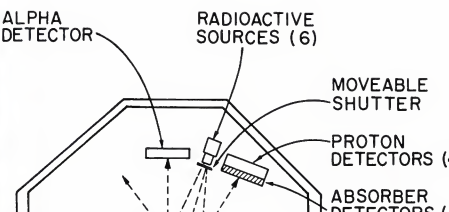
Hidden in a maze of underground rooms in the block-long Fermi Institute is Turkevich's laboratory where work is continuing on the analyzer. A duplicate of the box that traveled to the moon is located under glass on one counter. Originally sealed for flight, the shiny gold box now stands like a trophy in the small work room. A mirror placed in the bottom of the container reflects the inner mechanism of the box as it would be positioned above the soil of a planet.

The analyzer was designed and built at the University of Chicago under the direction of Turkevich, James H. Patterson of Argonne National Laboratory, Argonne, Ill., and Ernest Franzgrote of NASA's Jet Propulsion Laboratory, Pasadena, Calif. Turkevich recalls that Nobel laureate Harold C. Urey "inspired us to think of new ways of doing chemical analysis."

The theory behind the box is Lord Rutherford's alpha-particle scattering principle. Alpha particles (the doubly-charged nuclei of helium) from capsules of curium-242 are emitted from the instrument to bombard soil samples. When a particle hits the nucleus of an atom, it bounces back to the box. Sensitive detectors in the base of the instrument record the energy of the returning alpha particles and relay the message back to Earth. From this scientists are able to determine the composition of soil samples from afar.

The little gold box gave man his first glimpse of the geochemistry of the moon in 1967 when it was a passenger on Surveyor 5. "We were the first to show the moon must have had a chemical history," Turkevich said. "Before Surveyor 5 some people thought the moon was just an agglomeration of primordial material, solar system material, the same kind of material that makes up some of the meteorites . . . but we were able to show quite definitely that this isn't so, that is, the moon had a history in which chemical differentiation occurred."

Another important insight into the moon's composition was the analyses from the highland area, since the highlands make up approximate-




ly 80 per cent of the moon's surface. As the Chicago scientist said:

> They're very interesting in that the highland samples had appreciably less iron and titanium in them than the mare samples, and also more aluminum and calcium. We think, for example, this explains why the highlands are highlands. Second, why they're bright in appearance. . . . They're highlands because . . . the density of the material here is less than the mare material. So they're like icebergs floating on a denser material, and they stick up. They're brighter because elements like titanium and iron make rocks dark, and since this material has less iron and titanium it is therefore brighter.

For the Viking lander project, the gold box has been adapted to conditions different from those on the moon. The Mars box is smaller, lighter and more compact than the lunar one. A shutter that fits over the capsules of curium has been added to prevent radiation from escaping during the long voyage or interfering with ground radiation measurements after the landing.

Gold plating which was used on Surveyor to prevent overheating in the hot lunar sunshine is not needed on Mars where temperatures are not believed to be so extreme. Also, according to present blueprints, the instrument will not be exposed to the outside. Instead, a mechanical sample collector will go outside the craft, pick up soil, pulverize it and present it to the analyzer stationed inside.

It is expected that the box will not be affected by pre-flight sterilization at a high temperature.

In addition to analyzing the surface material on the red planet, the instrument has been adapted to detect the density and composition of the atmosphere. For example, it should be able to detect the presence of one per cent nitrogen in the carbon dioxide atmosphere of Mars.

The pre-prototype analyzer is tucked away in a solidly-built grey chamber in which the Mars atmosphere has been simulated. "It seems to be working pretty well." Would it be ready to go tomorrow? "In terms of the geography of our instrument, we would be willing to fly with that particular instrument, but it hasn't actually been packaged. And we don't know exactly what would be the constraints of the spacecraft," Turkevich said.

But right now the box isn't scheduled to be in the maiden Viking payload. "I think the people who defined the payload claim that it was meant to be a biologically-oriented mission to study whether there's any chance of life on Mars," Turkevich explained. "But there are known nonbiological instruments aboard."

NASA's Office of Space Science and Applications confirms this. Scheduled in addition to the biological instruments are two color video cameras, a seismograph, magnets and a soil manipulator. Other instruments will test molecular, atmospheric and meteorological conditions.

If the gold box doesn't make the trip, Turkevich feels it will be a mistake.

*Sally Jacobsen*

## SAKHAROV

(Continued from page 6)

about the drift of events, are nevertheless unable to join forces with the New Left because of their sense that the passions and demagoguery it indulges and condones are likely to become worse evils than the errors and abuses it derided and decries.

The 1968 Sakharov manuscript is truly remarkable for many reasons. First, it offers a deep study of the main international problems—world peace, the arms race, economic development, education, and population. Second, it outlines a plan and a timetable for coping with these problems through the joint efforts of the most wealthy and technologically advanced nations—particularly the United States and the Soviet Union. Third, but only in passing, it offers a rich contribution to what we may call "Sovietology" or even "Kremlinology," providing much data on the Stalin purges and other developments that were not otherwise known, at least to me. Fourth, it suggests some interesting ways of comparing the economic development in the United States and the Soviet Union, showing that Russia is overtaking America in the production of some commodities no longer vital in large quantities to a modern nation, while the United States is surging ahead in electronics and other domains of the present and future. In this connection Sakharov also speculates on the cost of a revolution in the United States, showing that the resources consumed by the upper classes are small compared to the annual growth rate that would be interrupted if widespread revolution went on for several years.

Following publication of the Sakharov manuscript in the West, rumors developed that the Soviet physicist had fallen from official favor and perhaps that he had been expelled from the Academy of Sciences. It appears, however, that he stopped doing work on classified military projects some time before writing the manuscript, and that although he may have left some of his earlier positions, he remains a member of the Academy and a member at the Lebedev Institute of Physics in Moscow. Expulsion from the Academy could be accomplished only by a secret vote within the Academy, a most unlikely development.

### *Oppenheimer and Sakharov*

The analogy is not perfect, but Sakharov's intellectual and moral history is similar in important respects to that of J. Robert Oppenheimer, key figure in the Manhattan Project leading to the U.S. atomic bomb. Both men fully recognized the dangerous potential of their research, but carried it forward for what may be termed soundly idealistic reasons: Oppenheimer in a race against Nazi Germany's development of an atomic weapon; Sakharov in an effort to end a U.S. monopoly in atomic and hydrogen weaponry. Sakharov has told Western scientists that he worked on the Soviet H-bomb program quite mindful of the negative aspects of Stalinism, but convinced that bipolarity would be more conducive to world peace than a monopoly of power by any one country. Stalin, he felt, would not likely abuse the power thus placed in his hands. It was in this spirit that Sakharov made some of the key contributions to the work of the teams headed by Igor Tamm that carried out the first hydrogen fusion experiments months before the United States. Partly because of Oppenheimer's reservations about developing an H-bomb, however, he was stripped of his security clearance whereas Sakharov may well have left classified military research of his own volition.

Oppenheimer lost his security clearance in the era of Senator McCarthy, but continued to the end of his life in quiet and articulate dignity as head of the Princeton Institute for Advanced Study. Even the titles of Oppenheimer's later books show some similarity to Sakharov's world view: for example, "The Open Mind," "Science and the Common Understanding." Men who have the creative intelligence to contribute to such scientific projects may well chafe at the restrictions and conventions of shortsighted governments, and their consciences may well be alarmed at how destructive their inventions will be if they are ever used by any governments. (The father of the American H-bomb, Edward Teller, however, remains a cold war hawk in every sense, arguing against curbs on atomic testing, against limits on ABM, etc.)

### *1970 Sakharov Letter*

The March 1970 letter of Sakharov and his colleagues has the merit of being much briefer than his 1968 memorandum, and hence can be typed and copied throughout the USSR via "samizdat"—the home printing procedures by which materials are reproduced which the Party does not permit to be disseminated through regular channels. This letter focuses on one aspect that is also present in the 1968 manuscript, one that is most relevant to the Soviet leadership—the need for greater freedom within the country. Sakharov and his colleagues contend that such freedom is required if the USSR is to go beyond the present levels and blind alleys of its economic and

scientific development. Without a complete exchange of information and freedom of thought, there will be stagnation, duplication of effort and wasted opportunities. (While not nearly so cosmopolitan and arms-control oriented as Sakharov, his American counterpart, Edward Teller, has also been urging the U.S. government in recent years to drop most secrecy procedures in the scientific field because American science would thrive in a more open arena.)

The 1970 Sakharov letter also comes at a critical period in the Soviet Union, when the forces of repression are again in conflict with pent-up drives for a freer society. Since Stalin's death there has been a secular trend toward greater liberalism, with sharp setbacks followed by gradual evolution toward enhanced freedom. The underlying force behind this trend may indeed be related to the inherent requirements of technological efficiency. But these tendencies seem also to be related to a kind of **Zeitgeist** that is sweeping the world, and which is reflected in the revolutions of students in many countries, the women's liberation movement and the mounting demands that the gap be closed between the haves and have-nots of all kinds.

There is a kind of paradox in the fact that though the means of power are increasingly destructive and can be monopolized by the central government, the central regime of a modern complex society becomes increasingly dependent on the cooperation and moral support of its citizenery if it is to function efficiently. As the United States is now learning in the wake of the Indo-China war, the unarmed civil disobedience, or "dropping out," of moderate numbers of young people can lead to wide demoralization affecting even the stock markets of the country.

The Soviet state might get along without Andrei Sakharov, but the Kremlin simply cannot afford to alienate large numbers of its creative intelligentsia. The Kremlin has tried to deal with such challenges by using direct and indirect methods, coercion as well as some concessions. In the short run, the government or, more specifically, the Party, holds most of the cards. In the long run, however, the Party must have the support of its people, particularly the technocratic intelligentsia, if sustained economic progress is to be made. Such progress, in turn, is the sine qua non for military research and development no less than it is for peaceful competition in trade or in terms of offering a model for others to emulate.

The potential influence of the Soviet intelligentsia was demonstrated in June 1970 when the protests of Sakharov and other scientists seemed to be instrumental in obtaining the prompt release of Zhores A. Medvedev, a biologist, not long after his arrest in Obninsk and his examination at a mental institution in nearby Kaluga.

### *Medvedev Case*

Medvedev, brother of the historian who co-authored the March 1970 letter to the Soviet Party and government, may well have been investigated because of his own writings championing intellectual freedom and his book "The Rise and Fall of T. D. Lysenko," published in the United States in 1969 but not in the USSR. Medvedev was also the author of "International Cooperation of Scientists and Foreign Borders," in part an account of his own difficulties in maintaining contacts with colleagues abroad. In 1969 he had been dismissed as head of the department of molecular biology of the Obninsk Institute of Medical Radiology.

Medvedev's release came after a number of telegrams and protests were sent to the Kaluga authorities from Sakharov, the nuclear physicist Pyotr L. Kapitsa and other members of the prestigious Academy of Sciences, as well as such people as Aleksandr T. Tvardovsky, the former editor of the liberal monthly "Novyi Mir." In October 1970 Medvedev began work as a senior scientist at the All-Union Scientific Research Institute of Physiology and Biochemistry of Agricultural Animals in Obninsk. According to a postcard mailed to the "New York Times" office in Moscow, Medvedev stated that his "present situation has substantially improved," and that he would be working in the field of molecular mechanisms and the development of aging organisms. Unfortunately, Medvedev's case does not establish any clear precedent or policy. It may even be an exception in a general pattern of exile or imprisonment for outspoken Soviet dissidents. The publication abroad in 1971 of another book by Zhores Medvedev (written in part by his brother Roy), "A Question of Madness," puts the author again in a direct confrontation with Soviet authorities.

### *Convergence Thesis*

Leaving aside the place of Sakharov and other scientists in the process of Soviet political life, what are the merits—and the prospects—of his ideas on the reform of international affairs? To begin with, his 1968 manuscript posits two main theses, which seem ever more persuasive with the passage of time: First, that "the division of mankind threatens it with destruction"; and second, that "intellectual freedom is essential to the development of human society."

To cope with the problems of our time, Sakharov calls for a strengthening of the tendencies toward "convergence" of the socialist and Western systems, and for their joint cooperation in attacking the problems of peace, economic development and ecology. "Such a rapprochement," according to his 1968 manuscript, "implies not only wide social reforms in the capitalist countries, but also substantial changes in the structure of ownership, with a greater role played by government and cooperative ownership. . . ." In the socialist countries, this rapprochement presumes "preservation of the basic present features of ownership of the means of production. . . ." But, he goes on, it will also depend on a broadening of freedom—intellectual, economic, political and cultural—in the USSR, and the overcoming of a poverty problem that may include 25 per cent of the United States population but 40 per cent of the USSR.

If we analyze the convergence argument, it seems to be a highly simplified conception of a complex reality, one that ignores many key variables, such as the historical imprint of the manner in which each society has industrialized. Thus, industrialization in the United States has been accomplished gradually, using decen-

tralized private enterprise; in Russia (even before the Bolsheviks) at a forced pace by directive from above. Still, the convergence thesis may well be more on target than off, even if it materializes in the 1980s rather than in the 1970s.

The main premise of the argument, as advanced by Sakharov, is that: "The development of modern society in both the Soviet Union and the United States is now following the same course of increasing complexity of structure and of industrial management, giving rise in both countries to managerial groups that are similar in social character." The main theoretical limitation to this argument (one that is underscored by Soviet critics of the convergence thesis) is that private ownership of the means of production remains the basic system in North America, even if government controls and social welfare programs increase. In the Soviet Union, at the same time, the means of production remain socialized (state-owned), though increasing responsibility is being given to managers of individual firms. If Sakharov is right, however, the restrictions that still bind these managers may have to be lifted, in the interest of efficiency and innovation. (To this we would add, some more flexible means must be found to "capitalize" young firms that want to develop some new idea or product.) As this process continues, what essential difference will it make if enterprises are owned by stockholders, by "society," or by the cooperative (as in Yugoslavia)?

### *Social Development*

Though Sakharov does not emphasize these points, the convergence argument could also point to the growth of scientific inquiry and education in both superpowers and to the trend toward mass affluence, even though large pockets of poverty remain.

The evidence suggests that—in the USSR no less than in the United States—education combined with relative affluence generates critical elites at many levels of society, not susceptible to intimidation or bribery, anxious and determined to change their societies. Contrary to the caveats of some sociologists, the emphasis in socialist countries on rote learning and engineering skills has not stifled an interest in the humanities or in social reform. Indeed, many Soviet scientists and engineers whom I have met display a remarkable breadth of interest and knowledge in artistic fields, often broader and deeper than that of the average Western social scientist diagnosing the shortcomings of Soviet society. All over Eastern Europe one notes that many persons concerned for more liberal development at home and internationally are engineers by training and by profession. One factor here may be that European and Soviet high schools are generally superior to American in providing an introduction to liberal arts before the student enters college. European and Soviet colleges are more specialized than U.S. col-

leges, but their students may continue an interest in literature and other liberal arts that was cultivated in the formative high school period.

Affluence is spreading in the Soviet Union, but this need not mean that the rising intelligentsia has been bought off so that there will be an end to all questioning. Indeed, if the U.S. example were to be followed, the evidence suggests that affluence generates not only discontent but also a disdain for security for its own sake. As early as 1958, David Riesman predicted for a group of Soviet editors that the children of an economically-secure generation in this country would scorn business and engineering for poetry and social work. As the Soviet people obtain greater free time and less need to direct most of their energies toward material concerns, they may come increasingly to value free discussion and criticism. As the title of a Soviet novel put it in the mid-1950s (paraphrasing the Bible), man lives "Not By Bread Alone." Similarly, Solzhenitsyn leads the reader of "Cancer Ward" to warm to the book's elderly doctor for whom "the meaning of life was to preserve unspoiled, undisturbed and undistorted the image of eternity with which each person is born."

### *Political Arena*

Even if the Soviet Union and the United States converge in economic and social development, however, it might still be a long time before the USSR approaches the political democracy of America. The forms and character of this democracy, of course, would be different. But how can a society guided by a single Party and a claim to absolute truth permit an element of free choice in the political arena? On this most sensitive issue, Sakharov and his colleagues have formulated a program in the fourteen points of their March 1970 letter. Three of the points are particularly important. The tenth point would permit "groups of citizens" as well as "public organizations" to organize and establish new press organs, thus breaking the Party monopoly on information. The twelfth point would overthrow the electoral system which makes a farce of the Soviet Constitution by permitting only one candidate to stand for election. If more than one candidate could run, this would offer a choice to the voter, thus making the elected official more responsible to his constituents instead of kowtowing to the peers or higher authorities who now decide which single man will run on the slate of "Party and non-Party candidates." The thirteenth point is related to this: It would extend the rights and responsibilities of the Supreme Soviet and other elected organs of government, that is, turn over to them many of the tasks now being carried on by the Party.

The November 1970 program for a Committee on Human Rights follows the same spirit of the March 1970 letter, for it assumes that private citizens can and should organize—outside the existing Party and government structure—to discuss

and act on political issues. Whether Soviet citizens actually possess the right to organize in this way, however, is not clear. Article 126 of the Soviet Constitution holds that Soviet citizens are guaranteed the right to form public organizations, but it also specifies that the Communist Party "is the leading core of all organizations of the working people both public and state." Further, Article 72 of the Russian Federation's criminal code makes it a serious crime to participate in "an anti-Soviet organization"—without making clear what constitutes such a body.

Sakharov and his colleagues, for their part, seem to believe that Soviet legal documents can be interpreted to support their movement. His group states that members of the Committee on Human Rights may not be members of a political party "or other organizations claiming participation in governmental management." At the same time, the group also excludes from committee membership anyone engaged in "opposition political activity." Similarly, cooperation with unofficial foreign organizations would be welcomed so long as "they proceed from the general principles of the United Nations and do not pursue the goal of bringing harm to the Soviet Union."

Like the 1968 Sakharov manuscript, the principles of the Committee on Human Rights posit that "the problem of the maintenance of human rights is important for creation of favorable conditions for people's lives, the consolidation of peace and the development of mutual understanding." The Committee noted the improvement in the protection of human rights in the Soviet Union since Stalin's death in 1953. The Committee went on to express its willingness "to cooperate on a consultative basis with the further efforts of the state in the creation of guarantees for the defense of rights, taking into account the specific character of the problem in the conditions of the socialist system and the specific character of Soviet traditions in this field." In line with the premises of the March 1970 letter, the Committee said that it wanted to cooperate with organs of state power in the field of the creation and carrying out of guarantees of human rights, either at the initiative of the committee or the initiative of interested organs of power. The group further pledged "constructive criticism of the contemporary conditions of the system of legal rights of personal freedom in Soviet law." This criticism, the Committee members affirmed, would be guided not only by the U.N. Declaration on Human Rights, but also by "the specific character of Soviet law" and "the complicated traditions and real difficulties of the state in this area."

Thus, the Sakharov Committee expressed its readiness to work with the existing authorities, even though Party and government personnel may not belong to the Committee. This is one of the ways that the Committee differs from the Initiative Group for the Defense of Civil Rights in the Soviet Union. The latter organization, formed in May 1969, was more explicitly critical of the Soviet system and appealed to the U.N. Human Rights Commission to stop the arrest of dissidents in the USSR. The United Nations, however, did not intervene, and many members of the 1969 group have themselves been arrested.

### *Influences on Sakharov*

The sources of Sakharov's thinking seem to be quite diverse. He and his colleagues read widely and they seem to exchange ideas in fruitful ways that interdisciplinary studies in America only aspire to. Some of the changes advocated in the March 1970 letter could be traced to political and economic practices in Yugoslavia. The concern with human dignity expressed by the November 1970 Committee may borrow something from the erstwhile Czechoslovak program for "humanizing socialism." It may also be traced to native Russian minds such as Soloviev and Kropotkin, long out of favor for their excessive "idealism," but discussed warmly, for example, by Shulubin in "Cancer Ward."

The notion that meaningful change can be accomplished within the system could also derive from Alexander Dubcek, but even more from the longer-lived example of Janos Kadar in Hungary. It may also be influenced by the example of U.S. scientists who have sought to mold their government's policies, as consultants but also as leaders of public pressure. The interest shown by many Soviet reformers in using existing laws and legal institutions as vehicles for defense of human rights is quite striking, and may also derive from U.S. models. Sakharov, in this sense, would be a kind of eclectic Ramsey Cark–Ralph Nader–William Dougles—in addition to his similarities to J. Robert Oppenheimer or Jerome Wiesner. Lectures on the U.S. Constitution in the Law Faculty of Moscow University by Harvard professor Harold Berman several years ago proved to be so well attended that they were suspended by fiat from above. In my own student days at Moscow University I noticed considerable enthusiasm when the U.S. Supreme Court dealt liberally with American Communists, and dejection when the Court took a hard line that made U.S. "democracy" seem little different from Soviet.

### *Implications for Peace*

If Soviet-style communism is to survive and prosper, changes of the kind advocated by Sakharov and others may be necessary, sooner or later. If such changes take place, however, this would mean that the aspects of communism to which Western liberals most object would be removed.

What would be the implications for international peace if the Sakharov program were implemented? First, we must recognize that East-West tensions derive from some real conflicts of power politics and from anxieties about the dynamics of the arms race, and not just from misperceptions or exaggerated concepts regarding the role of ideology. Even if a beneficent convergence occurred, this would not guarantee peace or cooperation between the superpowers. As Zbigniew Brzezinski and Samuel P. Huntington have pointed out, considerable links of trade, family and structural convergence among the nations of Europe did not prevent their fighting a mutually destructive war from 1914 to 1918.

On the other hand, the state of domestic affairs in the two superpowers is at least one determinant of their mutual relations. As George

F. Kennan argued in 1947, a totalitarian dictatorship in Soviet Russia might need to generate the image of a foreign bogy, if only to justify its repressive regime. From the Soviet standpoint, a U.S. government responsive to the needs of "monopoly capital" could also be expected to behave aggressively in foreign policy.

On balance, although convergence of the Soviet and Western systems would not create a panacea or lead inexorably to world peace, it might eliminate at least one source of international tension: the belief that one side or the other cannot survive indefinitely or that the adversary is less "moral" than "we" are. At the same time, many of Sakharov's proposals for international cooperation are not really contingent upon convergence, though it might facilitate their implementation.

Sakharov has much to say that is both sound and visionary on a series of interrelated problems of peace and development: the threat of nuclear war; trouble spots such as Vietnam and the Middle East; hunger and overpopulation; the psychology of racism; pollution of the environment; police dictatorships; threats to intellectual and other freedoms. On the subject of the arms race, for example, he endorses the arguments of Western writers such as Hans A. Bethe on the impracticality of antimissile defense, and joins those voices appealing for a moratorium on construction of such defenses, to be followed by a reduction of present arms levels. On the subject of hunger, although his estimate of a "tragedy" in 1975-80 may be premature, his call for joint action to prevent mass starvation is not.

Many of Sakharov's ideas on international development seem unrealistic, in detail if not in principle. Thus, he suggests that the United Nations should enforce the U.N. Declaration on Human Rights—a notion that would only increase the chaos of world politics. Presumably he would welcome U.N. action against racists in South Africa, but would he also believe it feasible for the world organization to defend civil rights in Mississippi or in Kazakhstan? It seems far wiser to adhere to the principle of noninterference in domestic affairs of other nations unless they threaten to expand into a threat to international peace and security. At most it would seem desirable to permit the United Nations to use moral or perhaps economic influence to gain respect for human rights, but certainly not violence—unless some internationally accepted legal principle is being violated. For example, by genocide.

Sakharov seems to understate the need for and feasibility of population controls, particularly for the third world. He seems to assume that in the third world population will decline as soon as economic development improves. In the short run, however, before that kind of development takes place, people may starve in large numbers and they certainly will go hungry. Further, there have been periods when economic prosperity brought on—at least for a short time—an increased birth rate. Further, there is the problem that improved hygiene will contribute to longevity in the third world. All of this underscores the need for population control as soon as possible. There are after all other methods besides sterilization—the only method alluded to by Sakharov.

Sakharov's plans for coping with the economic development of the third world and for reversing the arms race would make large demands on the imagination and good will of many concerned governments and peoples. He proposes that "a fifteen-year tax equal to 20 per cent of national incomes must be imposed on developed nations." Secondary benefits of this program, he suggests, would be a reduction in military expenditures and a stabilizing effect in most underdeveloped countries, "restricting the influence of extremists of all types." The principle of a surtax calculated against national income per capita is probably a good one, but Sakharov overestimates by a large fraction the willingness of the developed countries to be taxed at so high a rate and, equally important, the ability of the third world to absorb usefully such a high inflow of capital—many times higher than existing levels of investment and assistance. He also seems oblivious to the phenomenon that revolutionary demands often occur at times when social and economic conditions are improving, thus generating demands for greater and faster changes.

Sakharov's international program is deficient also in that it omits a positive approach to Communist

China. While demanding "universal cooperation," Sakharov adds that "ideological collaboration cannot apply to those fanatical, sectarian, and extremist ideologies that reject all possibility of rapprochement, discussion, and compromise; for example, the ideologies of Fascist, racist, militaristic, and Maoist demagogy." Sakharov may be too anxious to find at least some points of agreement with his own government (which he also supports on Vietnam, but not on the Middle East), but he seems to share the Kremlin's excessively self-righteous and shortsighted approach that merely perpetuates China's isolation from the world community. In an otherwise magnanimous and farsighted statement, the treatment of China offers no suggestions on how to deal with the not-so-sleepy giant of Asia: nothing about seating her in the United Nations; nothing about assuring self-determination for the Taiwanese; nothing about economic or technical cooperation with China.

### *In Summary*

Whatever its shortcomings, the Sakharov manifesto of 1968 constitutes perhaps the best all-round statement about the problems facing mankind in the near and long range future. It is many times richer and deeper, for example, than C. P. Snow's recent work, "The State of Siege." Sakharov's work is notable first for its scope, which includes problems of a scientific and technological character, those concerned with social development, and those concerned with the dignity of the individual. Second, it is notable for its objectivity, as the author attempts to provide both the negative and the positive evaluation of various phenomena. Third, it seems clear that Sakharov has a rather good understanding of history, literature and political theory as well as the theoretical and practical aspects of contemporary science.

Because of these qualities, Sakharov's 1968 statement is one that thinking people can endorse, whether they live in the West, the Communist countries, or the third world. Somehow the author has managed, for the most part, to transcend the limitations of ideology and of nationalism. Obviously, this is more difficult to do in the Soviet Union than it might be in the West.

The most profound weakness of Sakharov's approach derives from its basic strength: its extreme rationality. Sakharov writes and acts as though most men will, in the long run, respond to reasoned argumentation. He writes as though egotistical drives for wealth and power—even for blood-letting—could be eliminated if enlightment spread. His assumptions could prove unworkable when applied to power elites anxious to retain their privileges, or to the majority of the Soviet (or American) citizenry, often more concerned with gradual improvements in their living standards than with ultimate questions of truth or justice.

Indeed, who is to ensure that most scientists or technocrats will share Sakharov's vision of truth? If given power, like Albert Speer, may they not work for the Fuhrer no matter what task he assigns? May they not —like the sharashkas of Solzhenitsyn's "First Circle"—do their science in exchange for their daily bread?

Historical experience suggests a pessimistic answer to these questions. Nevertheless, at a time when the fate of the world as well as of individual countries depends upon the pursuit of enlightened self-interest, rooted in affirmation of international interdependence, one may hope that the rationalist approach may gain acceptance. If this approach fails, what other alternative may succeed?

There are a number of indications in Sakharov's statement that the East-West dialogue has been going better than some observers have thought. It is encouraging, not only to see his references to Western scientific literature, but also to consider his support for a moratorium on antiballistic missile deployment.

Naturally enough, the thrust of Sakharov's criticism of existing policies is directed toward those of his own government. His understanding of the American scene is to be appreciated, for example, his understanding of racial problems in the United States or his respect for the problems of innovating rather than following in technological development. A comparable statement by Western intellectuals, however, would have to be critical of their own systems of power and management based on the same kind of detailed analysis that Sakharov applies to his own country's problems. A similar task would confront intellectuals in countries of the third world, for Sakharov spelled out very few of the problems for which these regimes are themselves in large part responsible. In this sense, Sakharov's statement brings before us not only a proposal for collaborative action to deal with the present and future problems of world civilization, but also a challenge to thinking people in the West and in the third world to look more closely at the motes in their own eyes and not just at others' blemishes.

### *Future Open-Ended*

Convergence is not inevitable (nor is "parallel evolution" of American capitalism and Soviet socialism as discussed by Brzezinski and Huntington). Convergence need not be the cornerstone of peace and cooperation. But coexistence and intellectual freedom probably are essential to peace and development. The future may be more open-ended than we imagine. Unless we guide technological change and political-sociological-economic development in particular directions, the future may turn out to be a nightmare rather than a utopian blending of the best in the respective systems available today. Trends in either superpower could easily develop so as to contradict the humanist values espoused by Sakharov. Still, Sakharov has offered all of us a program for the future, one that should continue to be widely discussed. If we disagree with some points, we should improve on them. If we believe that some of his ideas are sound but premature, we should hold them before us as goals toward which to direct our near-term and medium-term policies.

Nineteenth century Russia spawned many "superfluous men"—men whose visions far outstripped the capacities of the Tsarist regime or the understanding of the masses. Sakharov, however, is not a superfluous man but one who is profoundly relevant to the enduring objective and subjective needs of industrial and post-industrial society.

# BULLETIN OF THE ATOMIC SCIENTISTS INDEX TO VOLUME XXVII, 1971

AUTHORS

TITLES

## BOOKS

# McGovern's Quiet Progress

McGovern? A great guy!

Would obviously be a great President — if only we could appoint him!

First U. S. Senator to speak out against our military intervention in Vietnam, way back in 1963.

Outstanding critic of the defense budget.

Lonely crusader against hunger in America.

Chief architect of delegate selection reform in the Democratic Party.

Consistently liberal but a big vote-getter in his conservative native state of South Dakota.

But the Democratic presidential nomination? Forget it. He doesn't have a chance. Starts from too far behind. And too nice a guy. Not fiery enough.

And so on and so on. Right?

This was pretty much the reaction when Senator McGovern shattered political precedent last January by becoming a declared candidate for the Democratic presidential nomination a whole year ahead of time.

**"They tell us that George McGovern cannot become President because he is too decent," wrote newspaper columnist Pete Hamill.**

**The Nation agreed: "His decency as a human being is a distinct liability."**

**But as The New Republic said during McGovern's hearings on hunger, "It is awfully hard to stop men like McGovern. They have iron in them . . . Don't underestimate him."**

And since he declared his candidacy, he has campaigned tirelessly and progressed steadily.

Now, people are beginning to rub their eyes in astonishment and say, "By golly, maybe he *does* have a chance!"

First of all, he has received nearly $500,000 from supporters, mostly in small contributions of $1 to $100. That's not nearly enough to carry him through all the primaries, of course. But it's a remarkable outpouring of sentiment so early in the game.

He's won the support of people with a lot of savvy and high standards, such as John Kenneth Galbraith, Gloria Steinem, George Wald, Hans Morgenthau, William Sloan Coffin, Arthur Schlesinger, Henry Steele Commager, Frank Mankiewicz, Shirley MacLaine, Blair Clark.

*In New Hampshire, he has the support of half the people who were Democratic Delegates in 1968 and three-fourths of the people who were McCarthy Delegates.*

*In New York, he has been endorsed by the Democratic Party Leader of Queens, Matthew Troy; the Borough President of the Bronx, Robert Abrams; and recent Democratic candidate for the U. S. Senate, Richard Ottinger.*

In Nebraska, former Governor Frank Morrison will serve as Chairman of Nebraska Citizens for McGovern.

"CROWDS HAIL McGOVERN IN WISCONSIN," read a headline in The New York Times on March 8. The news story which followed reported that "he drew about 4,500 persons to a speech on the University of Wisconsin campus, and the audience, noted for its intolerance of politicians, gave him a standing ovation at the end. Later, Friday, he drew another overflow crowd at a Madison hotel reception despite a driving snowstorm."

In Pennsylvania, the Philadelphia Evening Bulletin reported on July 29 that "The 1972 Pennsylvania Presidential primary is still nine months away, but Delaware County Democrats are reportedly already lining up support for South Dakota Senator George S. McGovern. Several local Democrats recently stated that support for McGovern has increased in the past few months.

"Every Democrat who has expressed an interest about becoming a candidate for delegate to the national convention is supporting McGovern," one leader said.

Students for McGovern chapters have sprung up on more than 350 college campuses.

**Tom Wicker of The New York Times told political writer Jack Newfield, according to Newfield's account in The Village Voice on August 12, "George is being under estimated. I think he is probably not getting the (newspaper) space he deserves. He is quite strong in the farm belt. He has real organizations going in some of those states. I think McGovern is going to win a primary, and then some folks are going to have egg on their face."**

*Maybe it's too soon to call all this a groundswell.*

But it's not too soon to say that McGovern is a serious contender for the presidential nomination.

And it's not too soon for you to make up your mind to help him get it.

The primary campaigns in New Hampshire and Florida begin in barely 60 days. After that comes Wisconsin.

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And you can play a part in helping Senator McGovern take his case to the people, by making a contribution to his campaign now.

The Pentagon papers have widened the credibility gap between the Administration and the country into a canyon. American people are hungering for a man they can trust — a man who sees the truth and tells the truth.

We think George McGovern is such a man. And we urge you to join with us in helping him win the Democratic presidential nomination, by mailing the coupon with your heartfelt contribution.

McGovern is getting there. Here's your chance to help.

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☐ **I support Senator McGovern in his efforts to lead our country along the path of peace, reconciliation and rededication. Enclosed is my contribution of $_____**

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☐ Mrs.
☐ Mr.

**Address** **Apt.**

**City** **State** **Zip**

☐ **Please enroll me in the McGovern for President Club made up of supporters pledged to contribute $10 or more a month until the convention, and keep me closely informed on the progress of the campaign.**

**Please Make Checks Payable to McGovern for President Committee.**

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# The gift cookbook of the season for ecologists, "consumerists," organic cooks and dieters, and everyone with a taste for gourmet meals


The New York Times

BY JEAN HEWITT

# NATURAL FOODS COOKBOOK

- Nearly 700 recipes selected by The Times for their good taste as *food* — not fad.
- **THE KIND OF MEALS YOUR FAMILY LIKES** — but without artificial flavors, colors, softeners, emulsifiers, bleaches, preservatives, chemicals or hydrogenated fats.
- Ingredients easily available no matter where you live.
- **FOOD TO SERVE WITH PRIDE** (and without apologetic pep-talks about its being natural or organic or "good for you").

If you think natural food is all pumpkin seeds and molasses, this new cookbook from The Times will come as a delicious surprise. It includes natural recipes for such international delicacies as Spanish gazpacho, French coeur à la creme, Italian ciambotta, Scandinavian fruit soup, Mexican guacamole, Russian borscht and Near East falafel. (You may find the fresh flavor and texture more authentic than versions you've served before — without the "American" taste of processed ingredients).

**"THE WAY FOOD USED TO TASTE"** This book is a modern treasury of the culinary wisdom that was second nature to our great-grandmothers, whether they were born in America or in the homelands of great cooking around the world. Some of the creative ideas go back to the early Amish and Shakers. Others derive from the traditions of South Seas, Chinese and Jewish cuisine. *A very deluxe tzimmes? (See chapter 7).* There are hearty meals to satisfy the meat-and-potatoes appetite. There are snacks, drinks, cookies and candies so sinfully good that it's hard to believe they aren't bad for you or for the environment.

The recipes are the result of a 12-month search by The Times. Famous chefs and gastronomes who have experimented with natural ingredients were consulted on ways to emphasize the benefits of the freshness advocated by good cooks from Escoffier to the present – and implicit in natural cooking. A series of advertisements in The Times itself invited knowledgeable readers to submit "recipes for dishes that have helped turn your family and friends away from highly processed foods". More than three thousand recipes were received, and the best of them are in THE NEW YORK TIMES NATURAL FOODS COOKBOOK.

**NEW WORLD OF DINING PLEASURE** There are 25 recipes for canapes, appetizers and hors d'oeuvres . . . 45 recipes for *making soup from scratch;* 15 for fish and seafood, *55 for meats and poultry;* 70 for vegetables; 55 for vegetarian entrees (don't knock them until you've tried them as alternatives to the excessive consumption of animal protein); 70 recipes for salads and really fresh salad dressings; 30 recipes for pancakes and pastas with great sauces; 90 recipes for home-baked breads *including quick breads, yeast breads and unleavened breads;* 140 recipes for desserts that range from a smooth, aristocratic Apricot Mousse to a mind-blowing concoction called Consciousness III.

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